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ABSTRACT

This proceedings of the 1993 convention of the Association for Educational Communications and Technology (AECT) contains 70 papers and 1 symposium. Topics addressed by the papers include computer-based mapping for curriculum development; educational technology equipped classrooms; individual characteristics influencing learning; network resources for teachers; educational partnerships; instructional motivation needs of adults; students' computer attitudes; qualitative research in instructional technology; instructional video; multimedia; problem solving; computer graphics; program control and learner control; distance education; computer simulations; cooperative learning; Channel One; groupware; restructuring library media centers; media and technology competencies; research methodologies; design of computer-based instruction; learner-computer interaction; constructivism; and library instruction. The symposium topic was critical theory, cultural analysis, and ethical aspects of the field. This volume also includes a list of Research and Theory Division officers; a list of the reviewers of the conference papers; a list of proceedings from 1979-92 together with their ERIC document numbers; a description of AECT and a membership enrollment form; and author and descriptor indexes. (MES)

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15th ANNUAL

PROCEEDINGS

of
SELECTED
RESEARCH AND DEVELOPMENT
PRESENTATIONS

at the
1993 National Convention
of the
Association for
Educational Communications
and Technology

Sponsored by the
Research and Theory Division
New Orleans, LA

aect

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15th ANNUAL
PROCEEDINGS
of
SELECTED RESEARCH AND DEVELOPMENT PRESENTATIONS

at the 1993 Convention of the
Association for Educational Communications and Technology
Sponsored by the Research and Theory Division
in
New Orleans, LA

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PREFACE

For the fifteenth year, the Research and Theory Division of the Association for Educational Communications and Technology (AECT) is sponsoring the publications of these Proceedings. Papers published in this volume were presented at the national AECT Convention in New Orleans, LA. A limited quantity of this volume were printed and sold. It is also available on microfiche through the Educational Resources Information Clearinghouse (ERIC) system.

REFEREEING PROCESS: All research papers selected for presentation at the AECT convention and included in this Proceedings were subjected to a rigorous blind reviewing process. All references to author were removed from proposals before they were submitted to referees for review. Approximately fifty percent of the manuscripts submitted for consideration were selected for presentation at the Convention and for Publication in these Proceedings. The papers contained in this document represent some of the most current thinking in educational communications and technology.

For the first time, a selected number of development papers, sponsored by the Division for Instructional Development (DID), are included in this Proceedings. The most important instructional development papers were selected by the DID program chairs for publication.

This volume contains two indexes. The first is an author index; the second is a descriptor index. The index for volumes 1-6 (1979-84) is included in the 1986 Proceedings, and the index for volumes 7-10 is in the 1988 Proceedings.

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1982	Dallas	223191 to 223236
1983	New Orleans	231337
1984	Dallas	243411
1985	Anaheim	256301
1986	Las Vegas	267753
1987	Atlanta	285518
1988	New Orleans	295621
1989	Dallas	308805
1990	Anaheim	323912
1991	Orlando	334969
1992	Washington, DC	347970 to 348041

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Table of Contents

Computer-Based Mapping for Curriculum Development
By Brockenbrough S. Allen, Robert P. Hoffman, Jacintha Kompella, and Thomas G. Sticht 1

Educational Technology Equipped Classrooms: Re-Design Based on Faculty Feedback
By James A. Anderson and Ronald R. Cichocki 25

Foundations Symposium: A Continued Dialogue on Critical Theory, Cultural Analysis and Ethical Aspects of the Field
Chair: J. Randall Koetting
Foucault and Disciplinary Technology
By Jane Anderson
Paradigms Reframed: Constructivist, Post-industrial, Modern or Postmodern Educational Technology?
By Denis Hlynka
Foundations and Technology in Education: A New Area of Study within the AECT?
By Al Januszewski and Elisa J. Slee
Post-modern Thinking in a Modernist Cultural Climate: The Need for an Unquiet Pedagogy
By J. Randall Koetting
Schools and Technology in a Democratic Society: Equity and Social Justice
By Robert Muffoletto
Critical Theory, Educational Technology, and Ethics: Helping Teachers Respond Meaningfully to Technology
By Randall Nichols
Where in the World is Jacques Derrida?
By Andrew R. J. Yeaman 53

Curiosity as a Personality Variable Influencing Learning in an Interactive Environment
By Marilyn P. Arnone and Barbara L. Grabowski 79

Wide-Area Network Resources for Teacher Education
By Ronald Aust 115

Promoting Success in Educational Partnerships Involving Technology
By Linda M. Baker 125

Using and Selecting Graphic Techniques to Acquire Structural Knowledge
By Katherine L. Beissner, David H. Jonassen, and Barbara L. Grabowski 155

Factor Analyses of the Instructional Motivation Needs
of Adult Learners
By Roy M. Bohlin, William D. Milheim,
and Karen J. Viechnicki 177

The Effects of Course Structure on Students' Computer
Attitudes
By Roy M. Bohlin and Nancy P. Hunt 193

Networking on the Network: Teachers and Electronic Mail
By John R. Broholm 199

Conducting Qualitative Research in Instructional Technology:
Methods and Techniques
By Cynthia S. Cashman and Phyllis McCraw 207

Learning from Video: The Influence of Preconceptions on
Invested Mental Effort
By Katherine S. Cennamo 215

Preconceptions of Mediated Instruction for Various Domains
of Learning Outcomes
By Katherine S. Cennamo 231

The Effects of Visual Complexity in Motion Visuals on
Children's Learning
By Lin Ching Chen 243

Facilitating the Spontaneous Generation of Analogies in
Problem Solving
By Peggy Cole and Brent G. Wilson 255

Learner-Generated Questions and Comments: Tools for
Improving Instruction
By Peggy Cole 265

A Review of Experimental Studies of Interactive Video Instruction
in Oral Communication
By Michael Cronin 283

Technology Implementation in Two Restructuring Schools:
Past, Present, and Future
By Michaeleen Davis and M. J. Henry 309

Error and Feedback: The Relationship Between Content Analysis
and Confidence of Response
By John V. Dempsey and Marcy P. Driscoll 325

Student Performance and Attitudes Using Peer Collaboration
in Accounting
By Martha S. Doran, Howard J. Sullivan,
and James D. Klein 335

Multimedia: A Gateway to Higher-Order Thinking Skills
By Lynn A. Fontana, Christopher Dede,
Charles S. White, and Ward Mitchell Cates 351

International Training Research Project
Culturefax
By David G. Gueulette 365

The Effects of Modeling to Aid Problem Solving in
Computer-Based Learning Environments
By Peter C. Honebein, Alison Carr,
and Thomas Duffy 373

Different Computer Graphics for Girls and Boys?
Preliminary Design Guidelines
By Sólveig Jakobsdóttir and Cynthia L. Krey 407

Hints and Learner Control for Metacognitive Strategies
in Problem Solving
By Miheon Lee Jo 415

Learner-Generated vs. Instructor-Provided Analysis of
Semantic Relationships
By David H. Jonassen and Peggy Cole 425

Distance Education: A Cost Analysis
By Judy I. Jones and Michael Simonson 441

The Effectiveness of Instructional Orienting Activities in
Computer-Based Instruction
By Richard F. Kenny 495

The Effects of an Interactive Dissection Simulation on the Performance
and Achievement of High School Biology Students
By Mable B. Kinzie, Richard Strauss,
and Jean Foss 517

Effects of Cooperative Learning and Incentive on
Motivation and Performance
By James D. Klein, John A. Erchul,
and Doris R. Pridemore 533

Effects of Cooperative Learning and Type of Reward on
Performance and Continuing Motivation
By James D. Klein, John A. Erchul,
and Doris R. Pridemore 543

Channel One: Reactions of Students, Teachers and Parents
By Nancy Nelson Knupfer 565

Groupware: A Tool for Interpersonal Computing
By Nancy Nelson Knupfer and Hilary McLellan 585

Restructuring Library Media Centers in Kentucky
By Mary Ann Kolloff and Sue P. Reehm 593

Interactivity and Multimedia Instruction: Crucial Attributes for Design and Instruction
By James J. La Follette 597

Empowering Learners Through Metacognitive Thinking, Instruction, and Design
By Ming-Fen Li 613

Configurational Inquiry
Instructional Development Perspective
By Chaucer Chaoyun Liang and Russell Kushigian 627

Teaching Self-Regulated Learning Strategies
By Reinhard W. Lindner and Bruce R. Harris 641

Reading Preferences of American Indian and Anglo Children for Ethnicity, Gender, and Story Setting
By Deborah L. Lowther and Howard J. Sullivan 655

The Effect of Interface Types on Learning and Satisfaction for Computer-Assisted Instruction
By Leslie A. Lucas and Leroy J. Tuscher 669

Procedures for Assessing Teachers' Computer Use Based on Instructional Transformation
By Henryk R. Marcinkiewicz and Paul W. Welliver 679

The Global Classroom: An International Perspective
By Marina Stock McIsaac 685

Computers Extending the Learning Environment: Connecting Home and School
By Teresa A. McMahon and Thomas M. Duffy 697

A Survey of Media and Instructional Technology Competencies Needed by Business, Industry, Health Professions, Agencies, Military Trainers, and Independent Contractors in Northern California, USA
By John E. Morlan and Mei-Yan Lu 719

The Critical Role of the ID in Interactive Television: The Value of Immediacy
By Karen L. Murphy and Charlotte W. Farr 731

Criticizing Instructional Materials Evaluation: Adding Meaningful Dimension
By Randall G. Nichols, Rhonda S. Robinson, and Beth Wiegmann 743

The Design of Effective Case Study-Related Learning Strategies Training
By Alice E. Nuttall 753

The Effects of Group Computer-Based Instruction and Learning Style on Achievement and Attitude
By Kay L. Orr and Gayle V. Davidson 781

Instructional Strategies for Metacognitive Development: An Inservice Design
By Kay A. Persichitte 793

Effects of Two Practice Strategies on Two Types of Recall
By Anthony A. Piña and Alan D. Richmond 797

Learner Control of Feedback in a Computer Lesson
By Doris R. Pridemore and James D. Klein 803

An Assessment of the Effectiveness of a Hypertext Instructional Delivery System When Compared to a Traditional CAI Tutorial
By Ann M. Quade 809

Pseudoscience in Instructional Technology: The Case of Learner Control Research
By Thomas C. Reeves 819

Qualitative Research Methods Workshop: An Introduction, Definitions, and Readings on Qualitative Research: An Annotated Bibliography
By Rhonda S. Robinson and Marcy Driscoll 833

What Motivates Graduate Students? A Descriptive Study
By Stephen Rodriguez 845

Digitized Speech as Feedback in Computer-Based Instruction
by Gregory C. Sales and Michael D. Johnston 851

Measuring Teacher Attitudes Toward Interactive Computer Technologies
By Wilhelmina C. Savenye 867

Classifying Interaction for Emerging Technologies and Implications for Learner Control
By Richard A. Schwier 881

Teaching Collaborative Problem Solving Using Computer-Mediated Communications
By Donna M. Scott, Karen L. Fowler,
and John J. Gibson 895

Qualitative Research? Quantitative Research? What's the Problem? Resolving the Dilemma via a Postconstructivist Approach
By Gary Shank 903

Varying the Narration Presentation Format and On-Screen Character-Narrator Relationship in an Instructional Science Film
By Greg Sherman 931

A Pilot Study: Comparing the Use of Computer-Based Instruction Materials and Audio-Tape Materials in Practicing Chinese
By Ka-fai (Stewart) Shiu and Sharon E. Smaldino 949

The Effects of Learner Control and Group Composition in Computer-Based Cooperative Learning
By Ali Simsek 953

Preschool Children at the Interface: A Cognitive Model of Device Difficulty
By Erik Strommen 991

Self Efficacy, Performance Variables and Distance Learning Facilitator Technology Adoption: Support for the Teacher Needs Hierarchy
By R. S. Talab and Bob Newhouse 1001

The Effects of Cooperative Learning and Learner Control on High- and Low Achievers
By Chanchai Temiyakarn and Simon Hooper 1021

Faculty Concerns as Gateways to Teacher Competency with Computer Technologies
By Nancy I. Todd 1039

Evaluating Interactive Instructional Technologies: A Cognitive Model
By Susan A. Tucker 1047

A Comprehensive Review of Learner-Control: The Role of Learner Characteristics
By Michael D. Williams 1083

Tracking and Analyzing Learner-Computer Interaction
By Michael D. Williams and Bernard J. Dodge 1115

Constructivism and Instructional Design: Some Personal Reflections
By Brent G. Wilson 1131

Evaluating the Impact of Technology at Peakview Elementary School
By Brent G. Wilson, Roger Hamilton,
James L. Teslow, and Thomas Cyr 1151

Thoughts, Feelings and Actions: Integrating Domains in Library Instruction
By Jane E. Zahner 1169

Title:

Computer-Based Mapping for Curriculum Development

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Computer-Based Mapping for Curriculum Development[1]

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Abstract

This article describes the results of a three-month experiment in the use of computer-based semantic networks for curriculum development. A team of doctoral and master's degree students developed a 1200-item computer data base representing a tentative "domain of competency" for a proposed MA degree in Workforce Education and Lifelong Learning (WELL).

The team gathered descriptions of knowledge that might be relevant to the proposed degree from state and national reports, existing course syllabi, textbooks, and interviews with subject matter experts. Using *SemNet*, a Macintosh-based program for constructing and analyzing semantic networks, they explored methods for organizing these descriptions as a "map" of related skills and ideas that would in turn serve as a framework for a WELL curriculum. The team explored various methods for using domain maps to define course content, to recommend learning activities, and to provide academic counseling to prospective WELL students. Among the innovative methods for conducting this experiment in curriculum development was the use of computer software for synchronous conferencing which allowed team members to collaborate in evaluating and integrating domain maps.

Curriculum development is a major concern at all levels of education since it encompasses the goals of learning, the scope and sequence of subject matter content, the interaction of the learners with the content, and methods for assessing the outcomes. In recent years, curriculum development has become a much more complex task because of the explosion of human knowledge, the increased variety of skills required for successful employment and citizenship, and the greater fractiousness of political debate over content and methods.

A steady stream of widely-cited curriculum theorists (Tyler, 1950; Taba, 1962; Hartley, 1968; Tanner and Tanner, 1980; Doll, 1989) have proposed criteria that might guide decision making in the curriculum planning process. However, curriculum development is hardly an objective or purely scientific enterprise that follows universal principles or a predetermined planning process.

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[1] *SemNet* is a trademark of the SemNet Research Group, a California Limited Partnership. *Macintosh* is a trademark of the Apple Computer Company, Inc. *Timbuktu* is a trademark of Farallon Computing Inc. The authors wish to thank Barbara Allen, Carol Breckenridge, and Stuart Grossman for their assistance in preparing this manuscript. Organizational affiliations are described for purposes of identification only; the opinions expressed in this report are those of the authors and do not necessarily represent reflect the policies of agencies or organizations cited herein, or of San Diego State University. Development of this article was partially supported by a grant from the Applied Behavioral and Cognitive Sciences, Inc. with funds from the William and Flora Hewlett Foundation.

Decision making in curriculum development is a function of tradition, historical and philosophical perspectives, social and cultural influences, and the political exigencies of the day. While all of these are important to the curriculum development process, there is a dearth of tools for systematic data gathering and rational analysis that might inform and support the kind of collaborative decision making that is essential for effective results. Such tools are especially needed in educational institutions that subscribe to contemporary theories of decentralized authority and management.

Using Maps for Curriculum Development

Fundamentally, this report addresses the need for new tools by investigating an experimental process for generating curriculum maps from concept maps. Since there is great diversity in the terminology that is used to describe conceptual and curricular structures, we begin by defining three types.

> **Curriculum maps** are representations of the structures employed by schools and other educational organizations as a means for assigning activities and allocating time intended to facilitate the development of student knowledge.
>
> **Concept maps** are representations of the structure of "public" conceptual systems, where "public" implies shared use of common terminology and language including—but not restricted to—forums such as publications, lectures and other presentations, discussions, and other formal and informal communication.
>
> **Cognitive maps** are representations of the internal mental structures of individuals that emphasize the meaning that individuals attribute to concepts; they may be used to describe expert knowledge, to diagnose or assess an individual's understanding of a knowledge domain, or to compare and contrast differences in the conceptual systems of individuals or groups.

Curriculum Maps

Among the obstacles to systematic curriculum development is the problem of sifting through large numbers of documents relevant to curriculum decisions: state and national reports and curriculum frameworks, text books, journals, existing syllabi and the like. Flowcharting and mapping techniques have been used for planning, implementing and evaluating the curriculum but computers have only recently been used to process the large amounts of information that are generated during curriculum development.

Fenwick English (1980) proposed the technique of "curriculum mapping" as a means of quality control. His approach emphasizes assessment of the extent to which learning tasks and/or learning time conform to standards delineated in a curriculum guide, and attempts to determine the extent to which what is actually taught is congruent with measures of achievement. A step-by-step guide for curriculum mapping can be found in Donald F. Weinstein's *Administrator's Guide to Curriculum Mapping* (1986). Curriculum mapping can be used to determine potential corrections and improvements in school programs. Essentially, English's use of the term "curriculum mapping" refers to a comparison (mapping) of an idealized curricular structure with an attempted implementation and we think, therefore, that a better term for the process he describes would be curriculum audit mapping. This is consistent with English's later work in curriculum auditing (English, 1988). We reserve the term curriculum map for each of the two structures that are being compared: the desired/required and the actual. Our report is concerned with methods for developing and using maps of the desired/required curriculum.

Another strategy for curriculum development and management can be found in Warren Hathaway's (1989) use of PERT-like networks to organize the curriculum and to manage instructional resources. PERT (Program Evaluation and Review

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Technique) charts are widely used in business and industry to plan and monitor parallel activities in support of common goals or outcomes. They are used to allocate and monitor resources, to estimate completion dates, and to determine ongoing progress. Hathaway's contribution was to show that such techniques could be applied to the achievement of instructional goals as well as the construction of buildings or organization of factories.

Concept Maps

In contrast to the systems proposed by English and Hathaway, which are directed towards institutionalized implementation and management, are approaches that focus on the conceptual organization of curricula. Typical is the work of Novak and Gowin (1984) who have demonstrated how concept mapping can be used to plan a total curriculum as well as specific instructional activities.

Before we discuss the use of concept maps for curriculum development, let us briefly examine the variety of concept maps and mapping strategies proposed in literature. Concept maps demonstrate structural relationships between concepts. Several types of structures/representations such as spatial maps (Holley and Dansereau, 1984), nested hierarchical maps (Miller, 1969; Johnson, 1967), graphic maps (Anderson and Bower, 1973; Quillian, 1968; Rumelhart et al, 1972) have been described. Preece (1978) has reviewed the research on various organizations of concepts in these maps. Although the different types of maps reflect different theories of semantic structure, Friendly (1977) suggested that the models were actually quite similar in their use of propositions and semantic distance data. Nevertheless, there are differences in the methods and conventions used to construct concept maps. We will briefly examine three approaches described by Holley and Dansereau (1984): networking, mapping, and schematizing.

Holley and Dansereau argue that networking is a fundamental tool for acquiring and developing individual knowledge. During acquisition, the student identifies important concepts or ideas in the material and represents their interrelationships and structure in the form of a network map. Students are taught a set of named links that can be used to code relationships between ideas. The networking process emphasizes the identification and representation of (1) hierarchies, (2) chains of logic, (3) clusters. An example of a network is shown in **Figure 1.**

Mapping is another technique used to represent knowledge. Several researchers have investigated concept mapping strategies. An elementary approach to mapping proposed by Hauf (1971) involves placing the central idea of a passage near the middle of a note page and attaching the subsidiary ideas in a concentric fashion, thus producing a product resembling a road map. According to Holley and Dansereau, mapping requires a set of relational conventions or symbols. In their

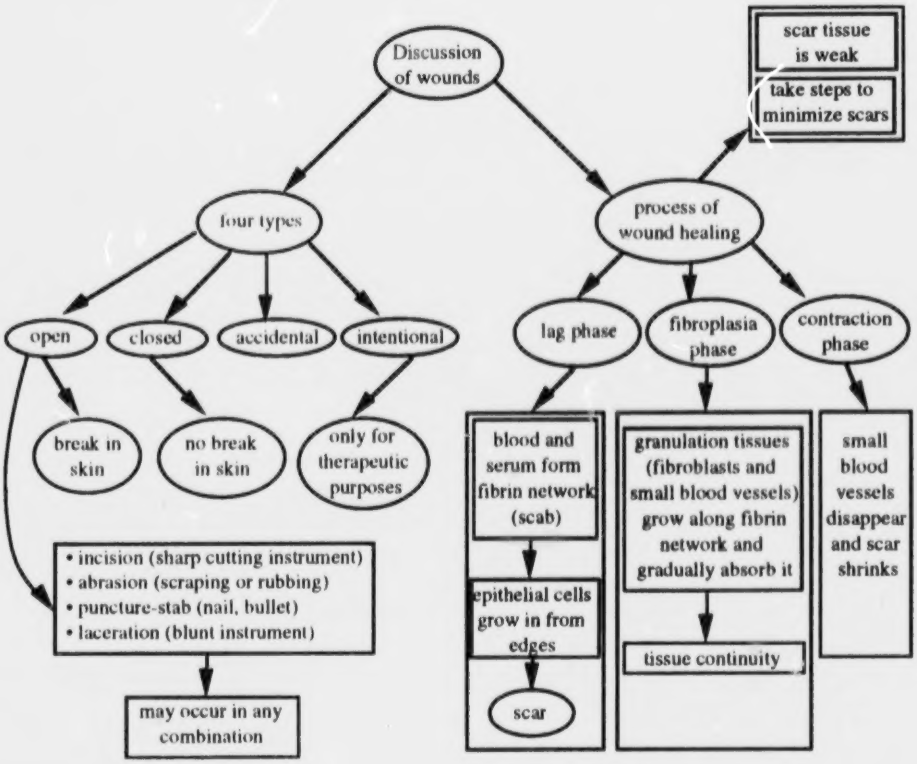
Discussion of wounds
scar tissue is weak
take steps to minimize scars
four types
process of wound healing
open
closed
accidental
intentional
lag phase
fibroplasia phase
contraction phase
break in skin
no break in skin
only for therapeutic purposes
blood and serum form fibrin network (scab)
granulation tissues (fibroblasts and small blood vessels) grow along fibrin network and gradually absorb it
small blood vessels disappear and scar shrinks
• incision (sharp cutting instrument)
• abrasion (scraping or rubbing)
• puncture-stab (nail, bullet)
• laceration (blunt instrument)
epithelial cells grow in from edges
tissue continuity
scar
may occur in any combination

Figure 1. Example of a network of a chapter from a nursing textbook (from Holley and Dansereau, 1984).

research, they provided students with symbols depicting seven fundamental relationships:

1. B *is an instance of* A;
2. B *is a property of* A;
3. A *is similar to* B;
4. A *is greater than or less than* B;
5. A *occurs before* B;
6. A *causes* B; and
7. A *is the negation* of B.

An example of a concept map developed by Stewart, Van Kirk, & Rowell (cited in Holley and Dansereau, 1984) is shown in **Figure 2**. For a review of relational descriptors see Allen and Hoffman (in press).

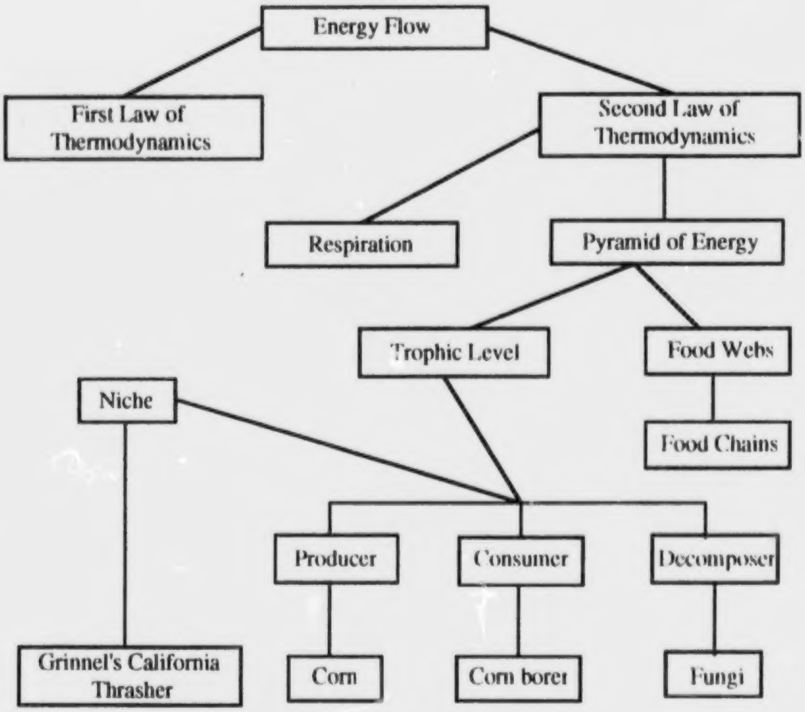
Energy Flow
First Law of Thermodynamics
Second Law of Thermodynamics
Respiration
Pyramid of Energy
Trophic Level
Food Webs
Niche
Food Chains
Producer
Consumer
Decomposer
Grinnel's California Thrasher
Corn
Corn borer
Fungi

Figure 2. A general concept map for ecology (from Stewart, Van Kirk, & Rowell, 1979 in Holley and Dansereau, 1984, page 238).

Novak and Gowin (1984) draw maps by linking concepts with relations derived from the text rather than using a specific set of relations. These relations are known as propositions. (Hauf, and Novak and Gowin actually use the verb "concept mapping" for their techniques. However, as noted earlier, we propose to use "concept map" as a noun to describe a much more inclusive set of conceptual representations.)

Another technique for knowledge representation described by Holley and Dansereau is called *schematizing* involves labeling and clustering concepts and depicting relationships between concepts by lines that are annotated to reflect the seven types of relationships. The general process for schematizing is represented in **Figure 3**.

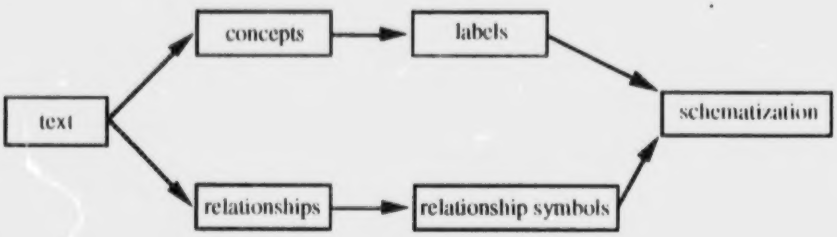
concepts
labels
text
schematization
relationships
relationship symbols

Figure 3. An example of schematization (after Holley & Dansereau, 1989).

The principal difference between networking and mapping appears to be that mapping emphasizes local organization rather than abstraction of an overall framework or schema, and that it employs spatial representations of relationships rather than labeled relationships. Schematization is similar to networking and different from mapping in that it uses annotated lines to represent relationships between concepts and it emphasizes the extraction of an overall framework or macrostructure. It is different from networking in the types of relations depicted, the method of annotation used, and the organizational structure of the resulting diagrams. The differences between these mapping strategies are superficial; they are more similar than different. We have used "mapping" in the title of this report in lieu of "networking" in order to avoid confusion with the use of electronic communication networks and professional networks.

Networking, mapping, and schematizing have been applied directly or adapted and modified to initiate various cognitive processes and achieve various learning outcomes. Concept maps help learners to extract meaning from written and oral communication. They have been used extensively to promote meaningful learning. Since curriculum development is a multi-faceted enterprise, the advantages of concept maps for curriculum development can be better appreciated if we examine the characteristics of concept maps that make suitable suitable for a variety of applications.

Applications of Concept Maps

Concept maps have been used for understanding text. The process of understanding text can be thought of as a transformation of sequences of words, sentences, and paragraphs into a coherent conceptual structure: synthesized knowledge. Carl Frederiksen (1975) presents a network model of logical and semantic structures from which speakers and writers generate linguistic messages at the discourse level. Book webbing is an extension of the use of concept maps for transforming text into spatial representations. Virginia Nordstrom and Victoria Clayton (1988) suggest the use of a form of concept maps to integrate multicultural children's literature into the curriculum. Book webbing uses children's literature to develop a study of one book; the works of a particular author or illustrator; a genre of books, such as poetry; or a topic, such as travel or magic. From the web's core based on a specific work of children's literature, the instructional possibilities of the book spin out in strands. As the plan develops, opportunities emerge to individualize instruction to meet the needs of each student's learning style and interest.

Concept maps have also been successfully used as advance organizers. Willerman and Harg (1991) conducted an experiment to determine if the use of concept maps as advance organizers improved the science achievement of eighth-grade students. They found that a concept map provided teachers with a meaningful and practical structured approach for introducing advance organizers in the class. In their study, a concept map developed by teachers was used as an advance organizer and was presented to students as a visual tool for organizing content. Willerman and Harg felt that the students were helped by the organization and visual relationships of the advance organizer in ways that are more effective than the assistance provided by a prose passage or an oral explanation. The concept map assisted the teacher in describing the relationships between important ideas and learners' knowledge.

Concept maps have been used as a guide to develop hypermedia applications. Authors need a way of representing knowledge structures so that: (a) they know the relationships between concepts and therefore do not make unwarranted leaps or linkages between them; and (b) end-users can see, at a global level, the interrelationships between concepts. If end-users can see the overall map of knowledge; then they can make informed choices about the order and sequence of learning (individualizing), and at the same time check that their sequence is coherent with more general understandings. Designers often resort to some form of mapping to analyze the content and sequence of instruction. Students in the Department of Educational Technology at San Diego State University also use a computer-based semantic network tool to map out concepts and relations in a particular knowledge domain. **Figure 4** is an example of a semantic network used to analyze content for a biochemistry laboratory course.

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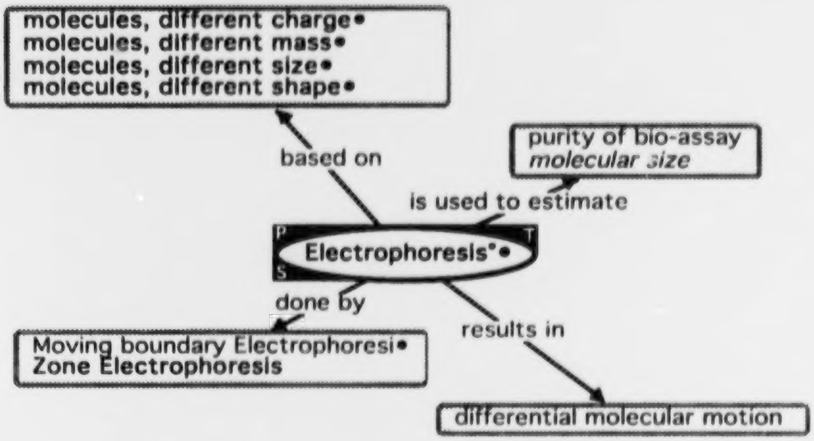

molecules, different charge•
molecules, different mass•
molecules, different size•
molecules, different shape•
based on
purity of bio-assay
molecular size
is used to estimate
P
T
S
Electrophoresis*•
done by
results in
Moving boundary Electrophoresi•
Zone Electrophoresis
differential molecular motion

Figure 4. An example of a semantic network used to analyze content for a multimedia course on biochemistry. The display is from a SemNet file. Clicking on the *P*, *T*, or S tabs activates supplementary fields for pictures, text, or synonyms (from Allen & Hoffman, in press).

Cognitive Maps

Cognitive maps may be described as representations of an individual's knowledge. Learning occurs when students link new concepts into more comprehensive structures and patterns. Each learner's associative patterns are unique and it may be useful to examine them in terms of the concepts the learners emphasize, the relations that link the concepts, and the strengths of these links. One study in this area was conducted by Kathleen Fisher (1989) who analyzed biology nets built by her students and obtained insights into the students' cognitive abilities that would have been difficult with conventional assessment methodology. Comprehensive essay questions do yield some information about the students' understanding of the subject matter; however, analysis is problematical.

Cognitive maps are also an excellent tool for representing the teacher's/expert's knowledge. According to Shulman (1986), teachers need both content knowledge and pedagogical expertise. The types of content knowledge they require can be broken into three categories:

- subject-matter content knowledge;
- subject-matter pedagogical knowledge;
- curricular knowledge.

All three types of knowledge can be analyzed and synthesized using concept maps. In developing subject matter content, teachers must go beyond the facts and concepts in a domain to consider patterns that reflect the substantive and syntactic structures of knowledge. These patterns help the teacher to convey the concepts in the domain. Perhaps even more important, they help the teacher to explain why a particular concept is worth knowing and how it relates to theoretical and practical issues both within the discipline and without. In the category of subject-matter pedagogical knowledge, Shulman includes useful forms of representation such as illustrations, analogies, examples, demonstrations, etc. These can be mapped prescriptively using relational descriptors that specify causal relationships between required learning outcomes and recommended strategies. The third category, curricular knowledge, is knowledge of the full range of programs, materials, and facilities available for teaching different concepts at various levels.

Shulman's categorization of a teacher's knowledge lends itself to an explanation of our method. The characteristics of concept maps that have been exploited for other applications can be brought to bear in rationalizing the curriculum design process. Concept maps can be used to show concepts and relations explicitly for subject-matter content analysis. Pedagogical strategies can be incorporated into the concept ma[illegible] and task allocations can be made. On the other hand, the curriculum designers and experts can incorporate their cognitive structures also into these maps. Thus curriculum developers can create what we will call integrated curriculum knowledge maps to first input the knowledge base, then reorganize it to suit the instructional objectives and finally extract a curriculum that can be justified. These integrated maps can be successfully used by curriculum developers to organize, analyze, and synthesize the information.

Integrated Curriculum Knowledge Maps

In previous sections, we have discussed three approaches to mapping knowledge: curricular maps are concerned with knowledge as it is represented by institutions for the convenience of educational delivery systems; concept maps are concerned with knowledge as it is publicly represented by a community that specializes in a particular knowledge domain; and cognitive maps are concerned with knowledge as it is represented in the minds of individuals. There are, of course, overlaps. For example, the creation and interpretation of concept maps is obviously influenced by the unique cognitive structures of individuals who author the maps. On the other hand, the assessment or diagnoses of individual student understanding through cognitive maps can be influenced by the concept maps used to represent the "knowledge domain."

This report is concerned with another type of overlap, or rather derivation: the development of curricular maps from concept maps. Although the use of concept maps for curriculum development is not new, the representation of large amounts of information in the form of a map that is suited for navigation, perusal, and processing is a new type of software engineering problem. Knowledge representation is one the of the central issues in knowledge engineering, a rapidly advancing field that offers many techniques (including concept mapping) with potential relevance to curriculum development (for a review, see Tuthill, 1990). However, to be practical for use in curriculum development, we believe such techniques must be brought to the level of "desktop computing" i.e., usable by professional educators, administrators, and other leaders whose primary expertise is not computer programming or information processing.

Tools for computer-based curriculum development must effectively support elicitation and organization of relevant knowledge from a variety of sources including reports, books, subject-matter experts, teachers and administrators. Such tools must also support analysis of relationships between curricular elements such as competencies and learning activities and the synthesis of structures familiar to educational institutions: courses prerequisites, scheduled class sessions, etc. They need to be supportive of collaborative work, open to modification and they must have a "learning curve" that does not impose an unnecessary burden on development specialists.

Such tools have only recently become commercially available in the form of computer-based graphical mapping tools which represent complex relational data as n-dimensional networks. One example, used extensively in this study, is *SemNet* developed by the SemNet Research Group (1991). *SemNet* serves as a framework for modeling human semantic memory—described by Tulving (1972) as "a mental thesaurus, organized knowledge a person possesses about words and other verbal symbols, their meaning and referents, about relations among them, and about rules, formulas, and algorithms for the manipulation of these symbols, concepts, and relations." Although cognitive psychologists have proposed several other types of memory, semantic memory is widely seen as crucial to the acquisition, processing, and retrieval of verbal knowledge and therefore central to learning, especially in school-like settings.

Semantic memory has been known to be associative since the time of Aristotle. However, it is only in the last two decades that associative memory has taken a firm hold with those interested in modeling human memory or providing working memories for "intelligent" computer programs. Semantic networks typically organize knowledge in terms of two types of elements: concepts and relations. Concepts are not easily defined but include a wide variety of entities such as ideas, objects, notions, beliefs, events, features, properties and states. For the purposes of this project, a concept represents anything that can be assigned an identity. New concepts are defined by relating them to pre-existing concepts.

SemNet uses object-oriented programming and the Macintosh graphical interface to display labeled nodes (referred to as "concepts") and labeled arrow-links (called "relations"). Node-link-node sequences are called "instances." It can be used to represent a wide variety of domains to the extent that they can be represented as semantic networks or propositional networks. In typical browsing maneuvers, users see a central node connected to its immediate "satellites" (see **Figure 5**). Clicking on a satellite node "moves" the frame so that the satellite assumes the center position thus revealing *its* satellites. In the process, the visible label for asymmetrical links will change. For example "*formative evaluation*—ISA—> *evaluation*" becomes "*evaluation*—is a kind of—> *formative evaluation*."

Moving through a sequence of alternating nodes and links generates a "path" which can be circuitous, that is a path that entails a single node several times. (This results when the user visits the same concept repeatedly.) Users can also move quickly and intuitively through large nets by selecting items in indexes, or by invoking utility commands such as "jump" and "replay path."

Easily-used commands afford several techniques for creating and modifying connections; experienced users can construct nets at rates exceeding several instances per minute *if* they are clear about how to organize their ideas. Users can assign graphics and short text passages to nodes and links (and in future versions will be able to assign video and audio segments to nodes). They can also export graphics and ASCII text representing indexes or net contents and subsets thereof.

The program provides a variety of metrics about the size and complexity of a net and uses these to assemble various types of summaries and overviews. Almost anyone who browses through a SemNet expresses interest in viewing "the whole net." This has proven problematical since SemNets are n-dimensional structures that cannot easily be visualized in two dimensions. But the problem has been addressed by special displays.

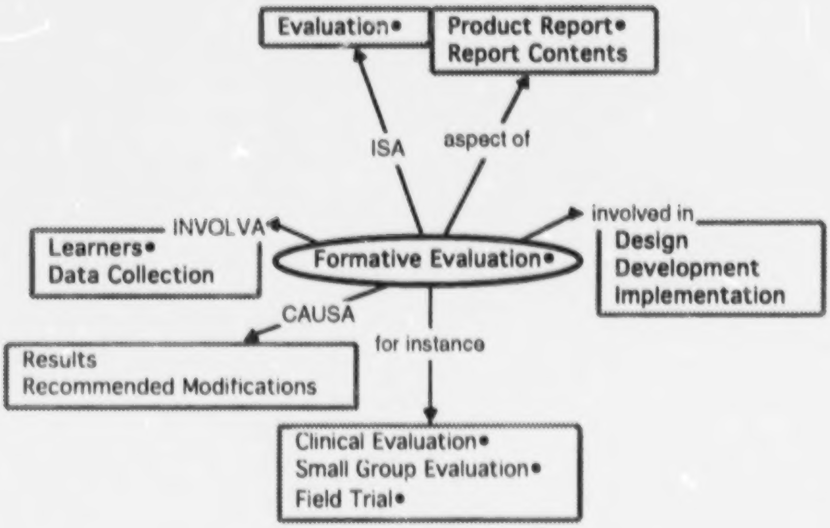

Evaluation•
Product Report•
Report Contents
ISA
aspect of
INVOLVA
Learners•
Data Collection
Formative Evaluation•
involved in
Design
Development
Implementation
CAUSA
Results
Recommended Modifications
for instance
Clinical Evaluation•
Small Group Evaluation•
Field Trial•

Figure 5. Concept map from a course on instructional design (from Allen & Hoffman, in press).

For example, measures of the "embeddedness" of concepts are used to generate a "knowledge core" in which the most embedded nodes are laid out in rows and connected by crisscrossed lines (**see Figure 6**). Other utilities let users see the shortest path between two nodes, or traverse the net viewing only node-and-satellite frames that meet user-established criteria.

Because *SemNet* uses a flexible, multi-dimensional graphic mapping strategy, it can be used for integrated representations of curricular maps, concept maps, and cognitive maps, and it can be used to derive structures in one map from structures in another. The experiments described here focus on deriving curriculum maps from concept maps. It is also possible to use *SemNet* to explore relationships between concept maps and curriculum maps one hand and individual cognitive maps on the other, but this is a subject for another report.

Development of an Integrated Curriculum Knowledge Map

To explore the possibilities of integrated curriculum mapping, a team of students drawn primarily from the SDSU-Claremont Graduate School Joint Doctoral Program in Multi-Cultural Education assembled under the direction of Dr. Brock Allen at San Diego State University. The framework for their efforts was provided by Dr. Thomas Sticht, President of Applied Behavioral and Cognitive Sciences. Dr. Sticht is developing a design for a model degree in Workforce Education and Life-long Learning.

The proposed WELL degree program will be aimed at producing educators capable of delivering basic knowledge and skills required for the workplace of the future. WELL Specialists are to organize and implement programs for the educationally underserved. This population includes high school dropouts, those with inadequate literacy skills for acquiring or maintaining a job, or those with jobs who are immobilized by the lack of such skills.

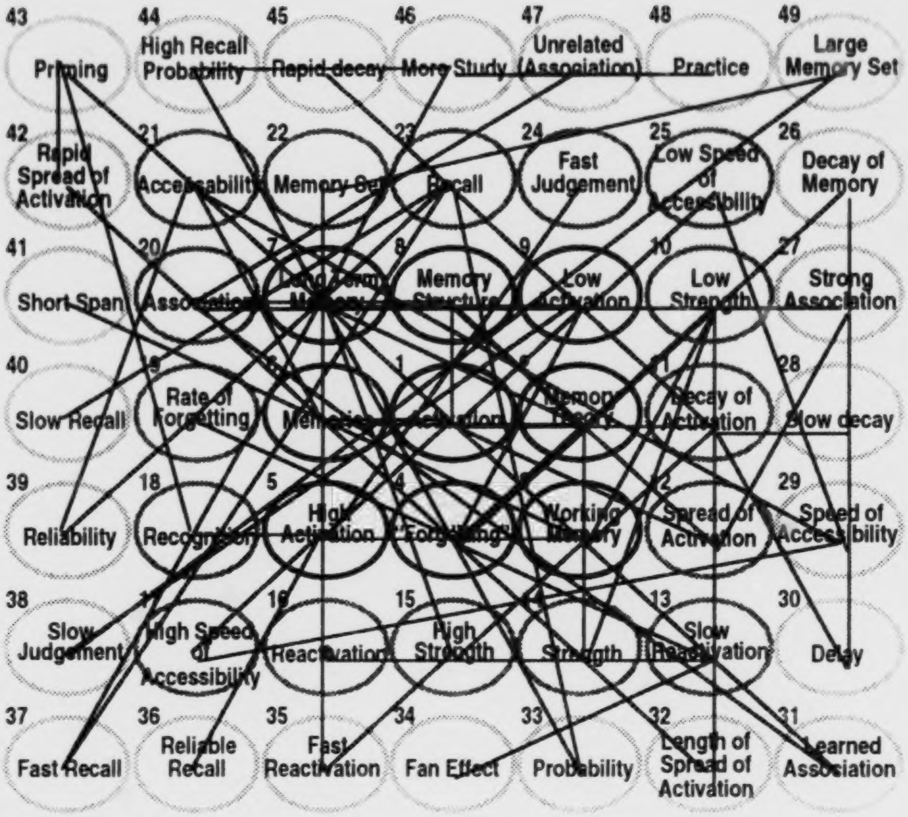

43
Priming
44
High Recall Probability
45
Rapid decay
46
More Study
47
Unrelated (Association)
48
Practice
49
Large Memory Set
42
Rapid Spread of Activation
21
Accessability
22
Memory Set
23
Recall
24
Fast Judgement
25
Low Speed of Accessibility
26
Decay of Memory
41
Short Span
20
Association
7
Long Term Memory
8
Memory Structure
9
Low Activation
10
Low Strength
27
Strong Association
40
Slow Recall
19
Rate of Forgetting
6
Memories
1
Activation
2
Memory Theory
11
Decay of Activation
28
Slow decay
39
Reliability
18
Recognition
5
High Activation
4
"Forgetting"
3
Working Memory
12
Spread of Activation
29
Speed of Accessibility
38
Slow Judgement
17
High Speed of Accessibility
16
Reactivation
15
High Strength
14
Strength
13
Slow Reactivation
30
Delay
37
Fast Recall
36
Reliable Recall
35
Fast Reactivation
34
Fan Effect
33
Probability
32
Length of Spread of Activation
31
Learned Association

Figure 6. "Knowledge core" from a concept map used in a course on instructional psychology (from Allen & Hoffman, in press). Some labels have been truncated.

The SDSU team first met in early September, 1991, with ten participants[2]. Their occupations ranged from teaching and counseling to instructional design. Areas of interest included administration and philosophy of science. Ethnic origin embraced the Pacific Islands, Mexican, Asian, African, and European heritage.

The team's primary goal was to demonstrate the use of computer-based mapping as an aid to curriculum development. They wanted to explore whether *SemNet* could serve as a means for assembling and organizing an integrated curriculum knowledge map encompassing potential competencies, course structures, and corresponding learning activities. A second goal was to develop a set of protocols and procedures for collaborative net building. A third goal was to lay the foundations of a database that would include competencies, course structures, and learning activities for the model WELL Specialist masters degree program.

A goal that emerged later in the semester was to demonstrate techniques for using *SemNet* to aid in the organization of courses and other high-level decision processes by identifying patterns in the raw data, unencumbered by categorization imposed by data sources.

---

[2] In addition to the authors, these were Alejandro Benitez, Thomas Gaffney, Caroline Huey, Rebecca Kvederis, Robert Reeves, Velma Sablan-Martinez, Linda Swanson, and Derry-Joe Yakubu.

An experimental process was adopted to accomplish the team's goals. This process was modified and refined during the course of the project, and from the team's experience we have extracted an idealized six-step model **(Figure 7).**

Process Description

The project began with a review of the social and political impetus for the model program, along with pertinent research. Three sub-committees were established to catalog descriptions of the knowledge WELL Specialists would need, focusing in three areas: cognitive foundations of education, educational arts and technologies, and human and cultural resources. Each sub-committee used *SemNet* to enter knowledge descriptors into a domain-specific subnet.

The three subnets were then combined so the entire team could collaborate to edit the main net and explore strategies for generating useful information from the net. Divergent terminology in both knowledge descriptions and the relations that are used to link them were reconciled as the subnets were combined into the main net. Merging was accomplished by manually reentering the subnets into a main net. More efficient merging capabilities have since been added to the *SemNet* program.

A Macintosh computer lab with an LCD overhead projector enabled team members to work together and to share nets and net-building techniques. *Timbuktu* (Killen et al, 1990) software allowed multiple users to control the activity of a single host computer. Outside the lab, traditional methods of file sharing, namely, floppy disk swapping and exchanging files via modem, were utilized.

1. Gather Relevant Descriptions of Knowledge

In the first step, subcommittees used *SemNet* to catalog knowledge descriptors gleaned from a variety of sources including reports, textbooks, subject matter experts, and existing course syllabi. For the purposes of this study we define a knowledge descriptor as a label for a concept or skill (or sets thereof) which may be of value to WELL Specialists in their professional practice.

2. Construct Hierarchical Links between Knowledge Descriptors

In the second step, hierarchical relations were used to represent the topical structures of the various source documents. This permitted efficient input of typically hierarchical sources such as reports, textbooks and course syllabi. It also enabled later extraction of the hierarchical structures in outline form using a *SemNet* hierarchical outline utility.

Hierarchical structures were entered prior to heterarchical ones when representing a given document. Consensus for this strategy emerged from divergent approaches taken by different subcommittees. One committee entered hierarchical and heterarchical relations concurrently. An instance entered with a heterarchical relation was not necessarily entered again with a hierarchical relation. This precluded later extraction of the entire document outline using hierarchical relations.

A second committee its work by cataloging knowledge descriptors from course syllabi, using only hierarchical relations at first. Later they used heterarchical relations to "cross-link" the knowledge the knowledge descriptors. The hierarchical structure reflected in the original source documents thereby remained intact and could be extracted even after extensive heterarchical cross-linking **(Figure 8)**.

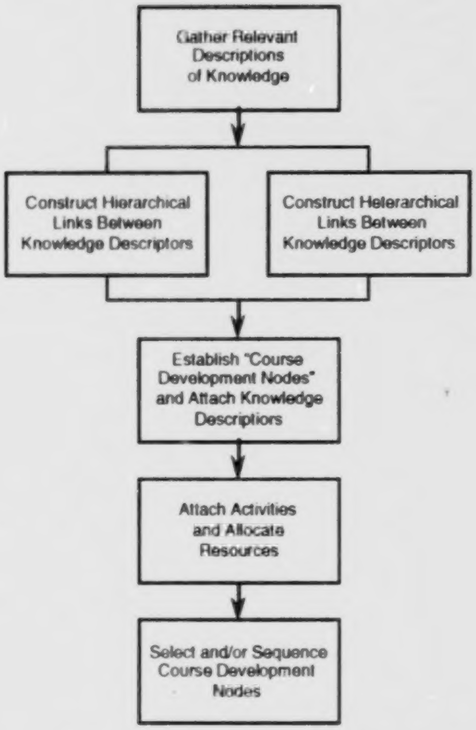

Gather Relevant Descriptions of Knowledge
Construct Hierarchical Links Between Knowledge Descriptors
Construct Heterarchical Links Between Knowledge Descriptors
Establish "Course Development Nodes" and Attach Knowledge Descriptiors
Attach Activities and Allocate Resources
Select and/or Sequence Course Development Nodes

Figure 7. An idealized six-step model for using a computer-based semantic network program to construct an integrated curriculum maps.

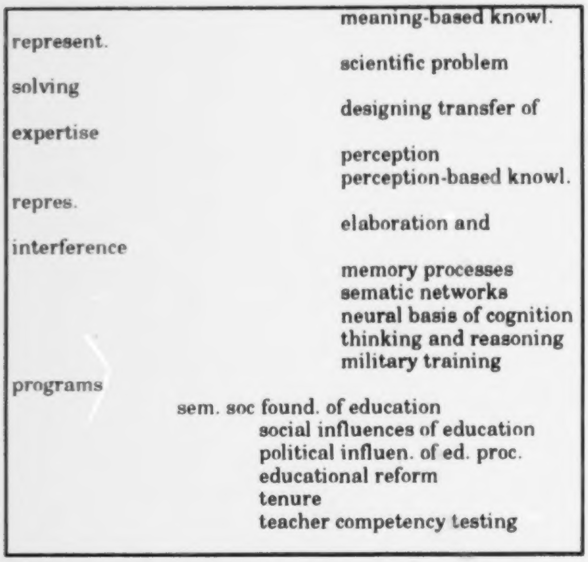
3. Construct Heterarchical Links between Knowledge Descriptors

The third step employed heterarchical relations, such as causal and procedural relationships, to cross-link the knowledge descriptors within and among documents (**Figure 9**). This step was carried out initially in the subnets and then again after the nets were merged into the main net.

The strategy for interconnecting nodes is one way to counteract the effect of top-down bias stemming from prior categorization imposed by the original authors of the descriptions of knowledge. The various syllabi, documents, and material from subject matter experts all came framed in their own categorical structures. The interconnect process was designed so that, hopefully, natural centers of gravity would emerge from the mass of knowledge descriptors in the main net itself, rather than from these prior categorical structures. To accomplish this, the teams first attended to those concepts that were *least* embedded or linked to other concepts in the net. It was assumed that later, once these simple units had been linked into compound structures, new patterns might become evident.

SemNet screens list concepts by the number of branches, by embeddedness, and in alphabetical order. Studying the list of concepts arranged in order of the number of branches or links to other concepts can help the curriculum developer get

```
educational technology
edtec 700 cogn. & inst. design
          edtec 700 cogn. inst. topics
                    cultural differences
```



```
                                    meaning-based knowl.
represent.
                                    scientific problem
solving
                                    designing transfer of
expertise
                                    perception
                                    perception-based knowl.
repres.
                                    elaboration and
interference
                                    memory processes
                                    sematic networks
                                    neural basis of cognition
                                    thinking and reasoning
                                    military training
programs
                     sem. soc found. of education
                              social influences of education
                              political influen. of ed. proc.
                              educational reform
                              tenure
                              teacher competency testing
```

Figure 8. The first portion of an outline generated by *SemNet* beginning on the node "Educational Technology" and based on the relation "has topic." Although many of these nodes have been extensively cross-linked to other parts of the net, the hierarchical structures of the original course syllabi have been extracted by isolating concepts linked by the "has topic" relationship. Limitations on the size of labels for concepts in *SemNet* necessitated abbreviation of knowledge descriptors.

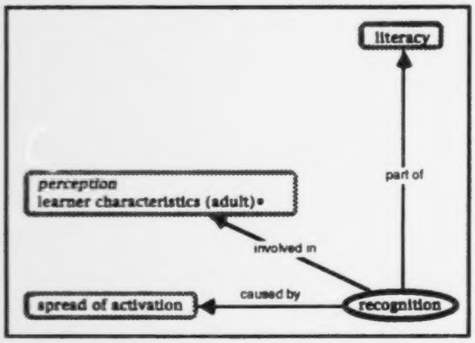


Figure 9. An example of a moderately-connected or "compound" concept. "Recognition" is linked in a variety of ways to other nodes within the curriculum net.

a sense of what might be the more important concepts (**Figure 10**). If a concept is important, or central, to a domain, it is presumed to have many direct connections to other concepts.

Listing concepts in order of embeddedness offers further evidence of centrality or importance. For example, if a concept has three related concepts, but each of those three concepts average, say, three related concepts each, then the original concept is said to have an embeddedness of 3 x 3 + 3 = 12.

Lists of concepts in creation and alphabetical orders were used more as net editing tools than as analytical tools. Creation order enabled later identification of separate documents represented within the net. Team members inserted marker nodes between documents to help in later distinguishing the sources of various competencies. Alphabetical order helped search for specific competencies during the cross-linking process.

Concepts by Number of Instances		**1238 items**
46	WELL Specialist	116
31	SDSU Learning Activities	87
27	literacy	179
26	Literacy Delivery System	136
21	problem solving	140
19	multicultural paradigm	79
19	administration	108
18	cognition	128
17	action research	146
16	thinking and reasoning	130
16	te 423 instructional topics	44
15	edtec 700 cogn. inst. topics	72
15	perception	83
15	restructuring	72
1	learning environment	12
1	content expertise	12
1	basic education (non-school)	2
1	Labor's Perception	8
1	articulate educative needs	10
1	inferential study	11
1	bottom-up processing	3
1	equipment	4
1	success	12
1	tools for representation	3
1	speaking	12

Figure 10. The beginning and end portions of the list of concepts in order of the number of branches or instances. The heading indicates that the net consists of 1248 items or nodes. The number to the left of each line of the list is the number of direct links or branches between the listed node and other nodes in the net. The number to the right indicates "embeddedness," which adds to the number of direct branches the number of the branches' branches.

Cross-linking of the subnets was carried out within subcommittees using a single computer and the print-outs described above. After merging the subnets, a somewhat different strategy was employed to cross-link within the main net. This took place in the computer lab, where each subcommittee had access to two or three computers. One computer in each subcommittee provided access to the master net through *Timbuktu* (Killen et al, 1990). Since only one computer could actually control the master net at any given time, a token was rotated among the subcommittees so that all would know where on-line editing activity was taking place.

The token was passed between subcommittees about every ten minutes or at a natural break in activity. During the twenty minutes or so when the token was elsewhere, each subcommittee identified those nodes in their net that could be linked to other concepts in the master net. To aid in identifying potential links, a second computer in each subcommittee contained an off-line copy of the master net as a reference and a third computer contained a reference copy of the subcommittee's subnet. The subcommittees also used various printed lists of concepts derived by using using SemNet's "traverse" utility.

Typically, while a subcommittee was "off-line," its members worked with a list of concepts arranged in order of the number of branches. They worked from the bottom of the list, beginning with the least-connected concepts. Taking each in turn, they scanned the alphabetized list of concepts from the master net to identify several possible links. For example, the concept "school restructuring" seemed to be related to the concepts "educational reform" and "organizational change" that had been entered by other subcommittees.

In order to check the meaning of all three concepts, the subcommittee "jumped" to each in turn on the off-line copy of the master net. They discovered that, indeed, the concept "restructuring" appeared to be related to the more inclusive concept "educational reform," based on the contextual links of the latter. A note was made to link them. However, the concept "organizational change," seemed to have a very specific context having to do with workplace issues, and a link was thought inappropriate. As other concepts were found to have important or interesting connections in the master net, the subcommittee kept notes until the token arrived. They then took control of the on-line master net and entered their changes. Concept by concept, the ideas became gradually more interrelated and embedded in the master net. On occasion there was doubt concerning the existence or meaning of a concept and the subcommittees would instigate oral communications in an effort to clarify or resolve differences.

After linking these simple concepts from the three original subnets into meaningful clusters or "compound concepts," the subcommittees turned to making links between the compound concepts. (Many of these had been formed earlier during development of the separate subnets.) Linking compound concepts produced highly embedded nodes that seemed to function as centers of "conceptual gravity" (**Figure 11**). The process of linking compound level nodes was conducted in the same fashion as that for linking simple nodes.

It should be noted that the student participants in this process were not subject matter experts in adult education or educational psychology and therefore the representations in Figures 11 and 12 are perhaps a bit naive. Our concern in this study was primarily with the process of curriculum development rather than content per se.

4. Establish "Course Development Nodes" and Attach Highly Embedded Nodes

In this step, teams developed structures for potential courses in the masters degree program. Of some 1,200 concepts, the master net yielded 48 with ten or more direct links to other concepts. Examination of the 48 nodes revealed that many could be thought of as central concepts in a master's degree program. Although time was

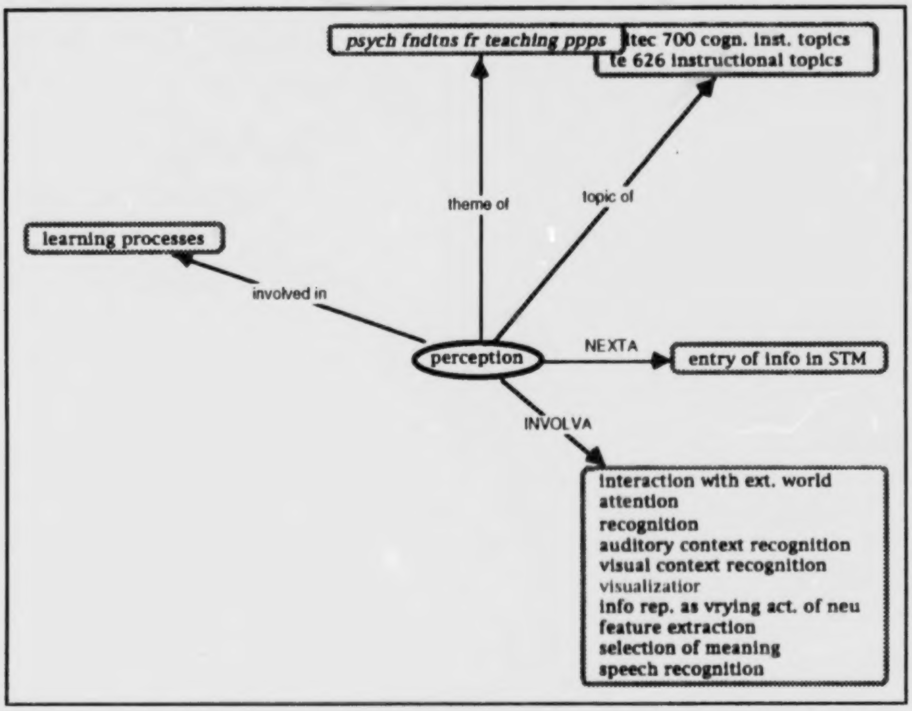

psych fndtns fr teaching ppps
tec 700 cogn. inst. topics
te 626 instructional topics
theme of
topic of
learning processes
involved in
perception
NEXTA
entry of info in STM
INVOLVA
interaction with ext. world
attention
recognition
auditory context recognition
visual context recognition
visualizatior
info rep. as vrying act. of neu
feature extraction
selection of meaning
speech recognition

Figure 11. An example of a highly embedded node. "Perception" is connected to a number of other nodes with a variety of relations. Those nodes listed in bold type have additional connections to other nodes, which may be displayed by double-clicking on them. The number of branches from "perception" would identify it as a potentially important concept for subsumption under a "course" node.

limited, the team experimented with creating a three-unit course and in less than an hour of discussion, they identified nearly a dozen thematic concepts that could be subsumed under a node they called "foundations of psychological development," **(Figure 12)** including such themes as "perception" and "cognitive development." This subsumption node was suggested as a tentative basis for a course or series of courses within the proposed degree program. This node was developed in a period of three hours by students without extensive expertise in psychology. Therefore it is illustrative of the course development process and cannot be considered as a recommendation for actual course content. However, it could serve as a rough framework for further discussion with content experts.

5. Attach Activities and Allocate Resources

The next step was to link various course themes to a battery of suggested learning activities. For example, a theme dealing with visual phenomenon might rely on textbooks, demonstrations, computer aided instruction, and laboratory activities. By identifying trends in learning activities that might be appropriate to the mix of subject matter projected for the program, allocation of facilities and resources would be facilitated.

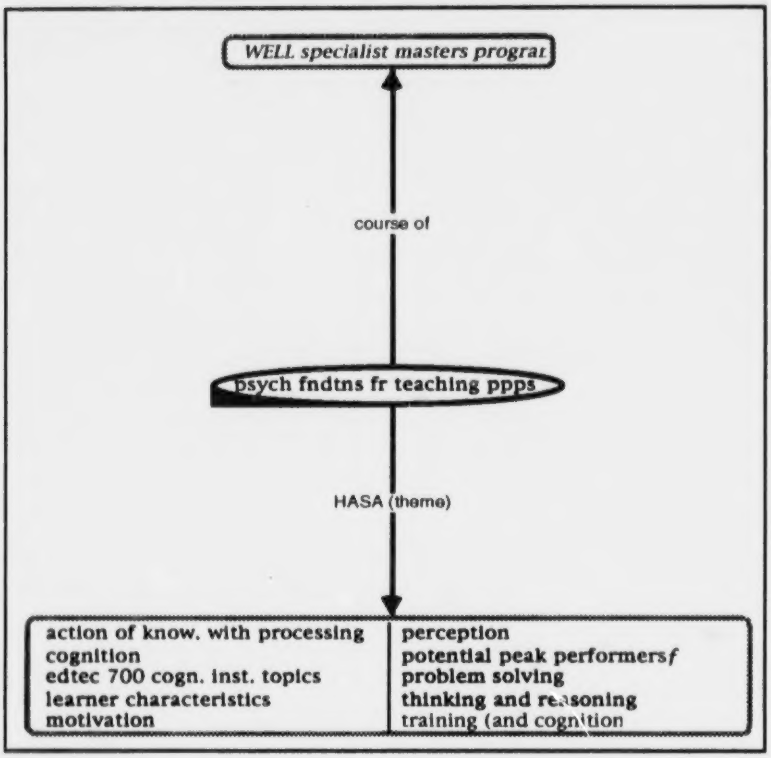

WELL specialist masters prograi
course of
psych fndtns fr teaching ppps
HASA (theme)
action of know. with processing
cognition
edtec 700 cogn. inst. topics
learner characteristics
motivation
perception
potential peak performers/
problem solving
thinking and reasoning
training (and cognition

Figure 12. Psychological foundations for teaching "potential peak performers" was established as a subsumption node and then linked to a number of themes, including "perception" (see **Figure 11**).

6. Select and/or Sequence Course Development Nodes

A number of proposals for using the main net were generated. In addition to course and syllabus compilation and resource allocation, both mentioned above, the net could be used by counselors and students to develop an individualized course of study. It could also be used to help prospective students make course selection decisions.

Using the Integrated Curriculum Knowledge Map: A Scenario

With the completion of the six-step process, the main net could be considered by our definition to be an integrated curriculum knowledge map since it incorporated structures that represented concept mapping (clusters of knowledge descriptors) as well as curriculum mapping (a course and clusters of course activities). To further explore the implications of the integrated map as a framework for the proposed WELL program, each of the team members worked with us to construct a scenario that addressed some practical problem in course development or individualized learning. Included here, in edited form, is one of these scenarios; it should be considered tentative and exploratory.

Rebbeca Kvederis, who directs career counseling services at Palomar Community College in California, describes how the integrated curriculum knowledge map could be used to counsel prospective WELL Specialists on the suitability of the master's degree program for their needs, capabilities, and interests.

She also examines the possibilities that the map offers for guiding individualized study plans.

Using Integrated Curriculum Knowledge Maps in Academic Counseling

Developed with Rebecca Kvederis

The essence of all counseling relationships, whether focused on personal, academic, or career issues, is to help the client "cope effectively with an important problem or concern, to develop plans and make important decisions to bring about a desired future, to acquire information about self and relevant aspects of the environment, and to explore and consider options available" (Eisenberg & Delaney, 1977, p. 3). College academic counseling is a process in which an academic counselor assists a student, or prospective student, in planning a program of studies. Counseling involves consideration of the current skills of the student (through portfolio review, assessment test scores, etc.), the interests of the student in terms of career and major goals, and the selection of courses from among those available to meet degree requirements.

Academic counseling is rarely a one-time event. College students request counseling as a means of gaining preliminary information about the options available to them prior to engaging in educational planning. Thus, the initial stage in this interaction is exploration and information gathering, leading eventually to the development of an educational plan. A plan may be retained or it may be rejected, often several plans are "tried on for size" before one is committed to.

Once an educational plan is written by the counselor and accepted by the student, it is implemented. Implementation of the plan (embarking on the course of study) leads to new experiences and interests that may result in further revision of the plan.

If the educational plan is a dynamic process, so is the counseling interaction that produces it. The counselor describes the requirements and the various options to the student and gauges the individual's interest based on verbal (and non-verbal) responses. Certain patterns and tendencies are noted in terms of the student's interests. These interest patterns influence the suggestions made by the counselor to the student regarding course selection.

The process of academic counseling and educational planning is limited by the available counseling tools, all of which are sequential and linear: catalogs, evaluation forms, and checklists of requirements. These encourage students to be passive in the counseling interaction since they establish an expectation that an authoritative list of requirements will be "given" to the student by the counselor, with little input from the recipient. A tool that moves away from the traditional, sequential presentation of information and incorporates the features of hypermedia would not only offer a more accurate representation of reality but would facilitate this dynamic process. *SemNet* is such a tool.

SemNet facilitates representation of various educational domains. Nodes represents clusters of skill or competencies. "Subsumption nodes" can be used to collect these nodes into traditional course structures and to assign learning activities to such structures. *SemNet* affords flexible representations curricular options. By "traversing" the net, the counselor and student can see and then select the courses or learning activities that would facilitate development of the needed competencies.

Using *SemNet* in counseling has other potential benefits. A student who is more actively involved in the educational planning process, who is taught to use the net to explore other options on his/her own, is more likely to see him/herself as responsible for and capable of planning an educational program. Also, the net may function as a sort of job aid for the counselor, cueing them to mention specific details related to the node under consideration.

The following is a hypothetical case study constructed to show how SemNet would be used in an academic counseling interaction with the goal of designing a course of study for a graduate student entering the proposed Workforce, Education, and Life-Long Learning Specialist masters degree program.

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The WELL academic counselor is meeting with José Luna, a third-grade teacher for the past fifteen years in the San Marcos School District. Mr. Luna desires a new professional challenge and wants to work with adults. He believes that his bilingual skills will make him especially valuable as an instructor in the district's adult education program. His goal is to become a program supervisor and he is especially interested in a position that would allow him to continue a small research project he began several years ago which looks at parental attitudes and the connection to children's learning successes among the Hispanic population. His research ideas stem from the theoretical concepts he learned as an undergraduate psychology major and Mexican-American Studies minor.

The initial appointment is scheduled to begin the dialogue between counselor and client and to discuss available opportunities. The counselor and client would view the WELL Specialist net together, using the "traverse" function—beginning with some of the basic knowledge domains and moving from the general to the more specific. Of the 60 most embedded nodes in the WELL integrated curriculum map, Luna will select 33 that are most closely related to his goals.

As a node representing a skill or knowledge descriptor is discussed in terms of Mr. Luna's existing skills and professional objectives, an accompanying text field would display the "market demand indicators grid" that is consulted to determine the importance of the particular knowledge description to the various WELL Specialist employment settings (See **Figure 13**).

The grid would indicate the importance of the knowledge—rated on a five-point scale—to three major employment settings: schools, corporations, and agencies. The scores would represent ratings by employers and previous graduates of the importance of the particular skill/knowledge to current jobs. This information would be updated biannually and will be based on questionnaires distributed to WELL graduates and their employers. The nodes of interest to Mr. Luna would be those with a "market demand indicators grid" score of greater than three for "school settings." These are flagged for future reference. After this process is exhausted, the "complete net grid" showing all flagged nodes and their interconnections would be viewed.

This initial academic counseling session would conclude with the scheduling of a follow-up session. Mr. Luna will be given a diskette containing the WELL Specialist net and instructed on how to use it at the program's computer lab so that he may work with the net independently to explore the possible options.

In the second session, the counselor and Mr. Luna would discuss the result of his work with the WELL Specialist net. A set of desired competencies will be identified, designed to balance his interests and the needs of the job market. The next step would be to view the options for "learning activities" that are attached to the selected nodes. These activities would include lecture, independent study options, and internship experiences. Mr. Luna selects a pattern of competencies that are subsumed within several three-unit courses: *Psychological Foundations, Sociological Foundations, Research Methods and Instructional Tools and Techniques.* These courses will be included in Mr. Luna's initial educational plan.

A perusal of the market demand indicator grid for the school settings suggests that knowledge of "organizational improvement" is important competency—in the opinion of employers and graduates. Mr. Luna and the counselor agree that

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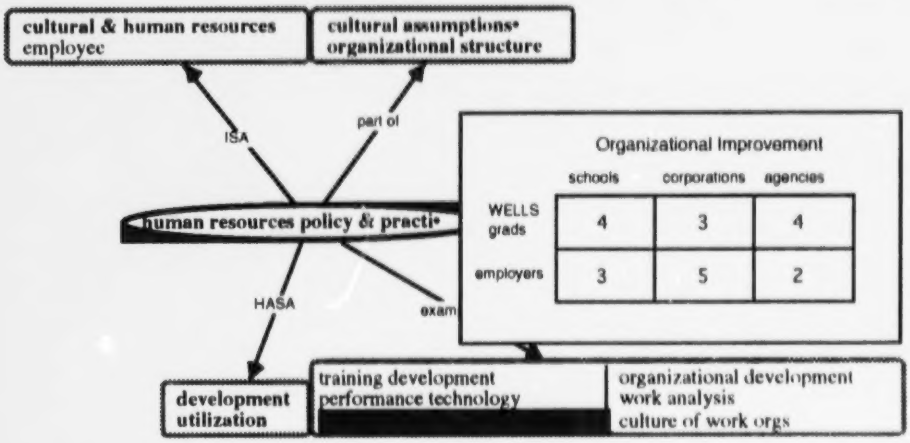
cultural & human resources
employee
cultural assumptions•
organizational structure
ISA
part of
human resources policy & practi•
HASA
exam
development
utilization
training development
performance technology
organizational development
work analysis
culture of work orgs
Organizational Improvement

	schools	corporations	agencies
WELLS grads	4	3	4
employers	3	5	2

Figure 13. "Market Demand Indicator Grids" accessible through selected "knowledge descriptor" nodes would provide estimates of the importance of a particular knowledge or skill element in three types of work settings. Ratings displayed are for "organizational improvement" and would be based on surveys of employers and graduates.

the independent study module represented in the map is a desirable means of acquiring this competency. In addition, Mr. Luna indicates an interest in pursuing an independent research project stemming from his earlier work with parental influence on Hispanic children's learning successes. He and the counselor decide that an action-oriented research apprenticeship, coordinated with a faculty member involved in this area of research, would meet this need.

At the close of the session, a list of courses and learning activities would be drawn up, providing Mr. Luna with an initial educational plan. He will be then encouraged to consult the WELL Specialist net again and to initiate a follow-up counseling session, with the understanding that as he begins to implement his plan, his new experiences and interests will possibly lead to revisions. His experience in using the WELL Specialist net and his access to information regarding the available competencies, learning activities, and market demand indicators will make him an active partner in this dynamic process of academic advising.

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Title:

Educational Technology Equipped Classrooms: Re-Design Based on Faculty Feedback

Authors:

James A. Anderson
Ronald R. Cichocki

Forward

The purpose of this paper is to give an overview of the most recent Educational Technology Equipped Classroom (ETEC) developed at the State University of New York at Buffalo. Emphasis will be placed on the re-design of the teaching station and how the various media and support technology are incorporated into the custom built podium. The rationale for some of the changes in this latest ETEC classroom, based on assessment of earlier classrooms and input from the faculty, are also discussed.

The authors had the privilege of presenting a paper, **Media Equipped Classrooms: Giving Attention To The Teaching Station**, at the 1992 AECT Conference in Washington, D.C. This current paper is an extension and further refinement of technology in the classroom. The earlier paper dealt with our initial Media Equipped Classrooms and the design of our original ETEC teaching station for the School of Management. Emphasis was placed on the rationale for change, the planning process, orientation of faculty, assessment of the teaching station as well as extensive CAD drawings and cost data. If interested, readers can obtain a copy of this earlier paper through the ERIC Clearinghouse on Information Resources (ED 346 841).

Although the overall responsibility for planning and implementing this project was assigned to the presenters, it could not have been successfully completed without the assistance and expertise of many of the staff in Academic Services and Operational Support Services, two units within Computing and Information Technology. In particular, the presenters wish to acknowledge Dr. Richard Lesniak, Director of Academic Services, Mark Greenfield, Supervisor of Media Equipment Services, William Maiman, Project Engineer, Assistant Engineers Mark White and James Crone, and Student-Assistants Jeffrey Gritsavage (a Civil Engineering student who developed the CAD drawings and a ergonomic analysis of the teaching station) and Aaron Somerstein (a School of Management student who provided general project assistance including configuring the teaching station PS/2 computer hard drive).

Background

State University of New York at Buffalo:

The State University of New York at Buffalo is the most comprehensive unit of the 64 campus SUNY system, enrolling approximately 26,000 undergraduate and graduate students. As one of four university centers, its mandate is to concentrate on upper division and graduate programs and research. It offers 93 undergraduate, 113 master's and 83 doctorate degree programs, as well as four professional degree programs and 14 graduate certificates. Faculties include not only the traditional arts and sciences divisions of Arts and Letters, Natural Sciences and Mathematics, and Social Sciences, but also the Undergraduate College, Millard Fillmore College (Evening Division) and Schools of Architecture, Dental Medicine, Education, Engineering, Health Related Professions, Library Studies, Law, Medicine and Biomedical Sciences, Nursing, Pharmacy and Social Work.

These diverse programs are housed on two separate campuses. The older South Campus in the City of Buffalo has been refurbished into a Health Sciences Center. A large new North Campus was recently completed in the suburb of Amherst, approximately five miles from the Health Sciences campus.

Computing and Information Technology:

During the Summer of 1992, a major organizational change took place in which the former Educational Technology Services, along with several other service units, were more closely integrated into Computing and Information Technology. The reorganization consolidated six separate units into four distinct units in order to take full advantage of the newer technologies; especially, computers, networking, communications technology and microcomputer software. This realignment of staff along functional commonalities should position the organization to provide improved support and development for facilities such as our ETEC classrooms and instructional support labs, in which the convergence of computing and the more traditional educational technologies is increasingly evident. Briefly, these four units are described as follows:

Academic Services, Computing & Information Technology

This unit focuses on instructional and research computing support, art and photographic services, media resources, network user support, information technology centers and UB micro computer sales.

Administrative Computing Services

This unit focuses on computer support for registration, student accounts, financial aid, housing, financial systems, admissions and data administration.

Technical Support Services

This unit focuses on software support of mainframe, UNIX and LAN systems, networking and office systems.

Operational Support Services

This unit focuses on computer, network and telephone operations; equipment repair; telephone services; and, facilities and systems engineering development for Computing and Information Technology.

In the design, development and support of the Educational Technology Equipped Classrooms at the State University of New York at Buffalo, expertise and support is drawn from Academic Services (media resources), Technical Support Services (LAN support) and Operational Support Services (design and installation, equipment repair and maintenance).

Introduction - Educational Technology Equipped Classrooms

Over the last four years, five medium size classrooms have been renovated at the State University of New York at Buffalo for the purpose of incorporating some of the latest presentation technology. The first three classrooms were referred to as Media Equipped Classrooms (MEC). They were not only designed to incorporate both video and computer display, but also reflected changes in the mode in which services were provided. Faculty teaching in a Media Equipped Classroom would have immediate access to a variety of media equipment and support technology without having to reserve the equipment prior to their class session.

The types of equipment placed in these MEC classrooms included an overhead projector, 35mm slide projector(s), 16mm motion picture projector, video tape player (1/2" VHS and/or 3/4" U-Matic), audio cassette tape recorder/player, sound reinforcement, laser pointer, microcomputer, video/data monitor or CRT projector, projection screens and custom designed cabinets to securely store this equipment. A telephone and data lines were also installed in each of these MEC classrooms.

Although well received by the faculty assigned to teach in these Media Equipped Classrooms, these facilities had some inherent problems. Faculty had to open up the storage cabinet (combination lock), remove the equipment, set it up and then at the conclusion of the class session properly secure the equipment in the MEC cabinets. When using a microcomputer, the display monitor and keyboard were pulled out of the cabinet (the CPU unit stayed inside of the cabinet) and placed on a desk. Not only were there a mess of cables to contend with, proper lighting at the teaching station was always a problem because the classroom had to be darkened sufficiently in order to display data through the GE Imager 310 projector mounted on the ceiling. These MEC classrooms, although a vast improvement over the traditional classroom, were not as the staff had hoped for, nor did they incorporate the latest in presentation technology.

The fourth renovated classroom, currently referred to as an Educational Technology Equipped Classroom (ETEC), incorporated some of the latest presentation technology. It was designed to support the curriculum in the School of Management and was ready for the beginning of the 1991 Fall semester.

This ETEC classroom features a custom designed teaching station (modular podium/ attached side cabinet) that houses a variety of electronic presentation systems including an IBM PS/2 microcomputer (model 55 SX which supports 80386 applications), a Wolf Visualizer (a CCD camera platform that converts transparencies, hardcopy and small three-dimensional objects to video), a Navitar VideoMate (converts 35mm slides to video) and a VHS videotape player. These "electronic" images are displayed on a large screen with a G.E. 410 Imager data/video projector mounted on the ceiling. Sound reinforcement (P.A. system) and audio recording are controlled from the teaching station. A laser pointer is also available.

Like the first three MEC classrooms, voice and data lines are an integral part of this Educational Technology Equipped Classroom. An auto/dial telephone is installed in the teaching station that terminates at the Media Equipment Services office. In the event of an equipment failure or an operational problem, the instructor can have immediate contact with a trained media specialist for assistance. In addition, the instructor can place calls to the Computing Center (DCA/Ethernet connections), School of Management Computer Laboratory, Office of Public Safety and the Physical Plant. A data line is also provided which permits the instructor to access an IBM mainframe computer, network servers, or numerous other connections and services provided through our University data networks.

A unique feature of this ETEC classroom is that it is connected to the School of Management's Local Area Network (LAN). When the IBM PS/2 computer is turned on, it automatically boots up into the School of Management's LAN system. The advantage to the instructors teaching in this classroom is that they can incorporate demonstrations using the

LAN's software and data files. Space is limited on the hard drive and there is no need to take valuable class time to load a software program into the hard drive of the IBM computer.

The LAN is wired using a Ethernet topology, the standard chosen by the University for networking computers. The Jacobs 110 ETEC classroom is one of 42 IBM PS/2 workstations connected to the LAN within the School of Management. The network uses an IBM PS/2 Model 70 personal computer as a file server. The file server's 120 MB drive stores the Novell and DOS operating systems as well as all the necessary application software and printing utilities.

At the workstation level (e.g., the Jacobs 110 ETEC classroom), the user ID is the workstation. Each workstation has a PROM chip and an Ethernet board to make the connection to the file server when the work station is turned on and to identify that particular workstation. This configuration allows all processing to be done at the Jacobs 110 ETEC workstation. Using the Novell feature of distributed processing, the burden of most of the input/output requests is handled by the memory of an individual workstation within the network. This feature prevents the typical slow down problem many networks experience when the server must use its own memory to manage input and output requests from all the other workstations on the LAN. Approximately 40K of the memory in the Jacobs 110 workstation is used for the network shell. The shell interprets each request made by the user and directs the request to either the file server or DOS, depending on the type of request

At the conclusion of the 1991 Fall Semester a questionnaire was sent to all faculty teaching in this first ETEC classroom. Out of the fifteen questionnaires sent out, fourteen faculty responded. In general, everyone who responded was quite pleased with the technology made available. Yet, there were criticisms. Some were dissatisfied with the quality of the image of the Wolf Visualizer. Most felt that the current placement of the visualizer made it awkward to use. Many asked for more surface space on the teaching station to layout their lecture notes and presentation materials. At the completion of the 1992 Spring Semester the same questionnaire was sent out to the faculty teaching in this ETEC classroom and the same conclusions were replicated. Selective follow-up interviews were also conducted to assist in arriving at some possible solutions to these criticisms.

Many of the School of Management faculty indicated that they could not take full advantage of the technology unless they redesigned their courses and it would be difficult to justify the time or effort it would take unless they were assured of being assigned to an ETEC classroom in the future. Unfortunately, the majority of the faculty assigned to teach in this ETEC classroom in the 1991 Fall Semester were not assigned to this classroom for the 1992 Spring Semester. A fair amount of disappointment was expressed by the School of Management faculty. A positive outcome of this disappointment was that endowment funding was identified by the School of Management to develop a second ETEC classroom.

The planning of this second ETEC classroom for the School of Management provided an opportunity to alter the design of the teaching station and to make appropriate improvements where feasible. The remainder of this paper will discuss this new ETEC classroom and the improvements made, based on faculty feedback.

Educational Technology Equipped Classroom -- Re-Design

This second Educational Technology Equipped Classroom (ETEC) is located in 112 Jacobs Hall and replicates the same presentation technology as the first ETEC classroom located in 110 Jacobs Hall. This new classroom is slightly smaller in seating capacity (55 students) and has some subtle, yet significant improvements in the design of the teaching station as well as some improvements in the processing of video signals and image quality. It should also be noted that the changes incorporated into the teaching station of this second ETEC classroom were also retrofitted into the earlier teaching station in 110 Jacobs Hall. This retrofit could be accomplished at minimal expense due its modular construction. Also, it was felt that both of these ETEC classrooms should be replicated as closely as possible because School of Management faculty could be assigned to teach in either classroom depending on course scheduling and class size.

Planning and Implementation:

Like the earlier Jacobs 110 ETEC classroom, faculty input was sought through questionnaires and meetings. After their initial input, several informal review sessions were held with the faculty to keep them appraised of developments and to gather appropriate feedback. Faculty input is see as absolutely essential if these ETEC classrooms are to be accepted and fully utilized.

A classroom assessment was carried out by the project engineer (Operational Support Services unit) utilizing criteria developed for the earlier MEC and ETEC classrooms. The assessment would determine what problems, if any, existed that would prevent or hinder the proper utilization of media equipment and other kinds of classroom support technology. Issues such as viewing distance, site lines, window blocking, zoned lighting, acoustics, ambient noise, electrical outlets, etc., all affect proper utilization.

The classroom selected (Jacob 112) has a student seating capacity of 55 and met all of the basic criteria. An added feature was that this was a tiered classroom with no windows. Zoned incandescent lighting was already in place as well as an electric wall screen. CAD drawings depicting room layout and site lines are in the Appendix.

The rehab of the classroom took place over the 1992 Summer recess and was carried out by both the trades staff of the Physical Plant and the Operational Support Services staff. The teaching station (podium and side modular cabinet) was permanently fixed in place and conduit run for electrical service and control circuits. All conduit was either trenched in the floor or run in the ceiling. A distributed speaker system was installed in the ceiling as well. All component installation, control circuits and wiring was handled by the Operational Support Services staff.

The overall project took less than six months from start to finish. Approximately three months was spent in planning, design and procurement of equipment. Classroom rehab and installation of the equipment took less than three months. Everything was completed in time for the start of the 1992 Fall semester.

The Teaching Station:

The teaching station consists of a custom-built podium and an attached modular cabinet. Like the earlier Jacobs 110 ETEC classroom, CAD drawings and specifications were developed by the Operational Support Services staff and the unit was custom built by Rabco Design, Inc. of Buffalo, New York.

The significant changes between the earlier teaching station and the current teaching station are in the placement of the Wolf Visualizer and its controls, and the placement of the podium surface lighting. The earlier design placed the Wolf Visualizer on a pull-out shelf and it was accessed from behind the modular cabinet. When the visualizer was in use, the instructor had to stand away from the visualizer and behind the podium which made it awkward to use. The instructor found it difficult to use the surface of the modular cabinet for presentation materials and lecture notes and the visualizer controls were difficult to use because of placement and design.

The Wolf Visualizer is now located on a drawer unit which pulls out to the side of the modular cabinet. A more simplified control pad was custom designed and placed on the top surface of the modular cabinet. The podium lighting was changed from florescent to incandescent and raised a few inches to better illuminate the podium work surface and reduce glare on the instructor's monitor screen. The height of the modular cabinet was also raised a few inches to make the platform of the visualizer more comfortable to use.

Other advancements were made in the electronic circuitry and signal processing. In the earlier ETEC design, only data could be displayed on the podium monitor. Through a scan doubler, both data and video are now displayed on the podium monitor. This allows the instructor to view the same image on the teaching station monitor that is displayed in the classroom through the video/data projector. Alternative approaches were considered to accomplish this design objective (a multi-scan monitor, IBM UltiMedia M-Motion Video, IBM PS/2 TV). Each of these were rejected for a variety of reasons which are too involved to discuss in this paper. The use of a scan doubler for all video signals also brought improved image quality to the front classroom seats by eliminating visible scan lines in the projected image.

An ongoing ETEC design objective is to continue to incorporate improvements which will result in making the computing system(s) more responsive to instructor commands (i.e., faster access to applications, increased speed in interactive sessions, etc.). The PS/2 computer was upgraded from 30 to 80 MB hard drive and the RAM was increased from 2 to 4 MB in order to accommodate new software and allow the system to be more responsive. By also going from a DCA to an Ethernet data network connection, the data throughput rate was significantly expanded (9.6 Kbps to 2-3 Mbps).

The podium and side cabinet are constructed and finished as separate, stand-alone items with 3/4" particle board construction. The interior and exterior are finished with Formica brand laminate. The podium keyboard shelf and the pull-out drawer and one shelf in the side cabinet are on slide-out rails. All other shelving is adjustable. The three doors (one cabinet door and two podium doors) are fitted with hinges allowing doors to be opened a full 270 degrees. The doors are opened with matching combination locks.

The top surface of the podium contains a flush mounted monitor and the system's control panel. When the top door of the podium is opened the keyboard shelf can be pulled out. The auto dial telephone, VHS videotape player and computer (CPU) are also accessible in this compartment. The lower door is not accessible by the instructor. This compartment contains control and security systems.

The top surface of the redesigned side cabinet now serves as a table top for instructor notes and presentation materials. When the door of the side cabinet is opened, the drawer unit for the Wolf Visualizer can be unlatched and pulled out. The arm of the visualizer is then extended and the unit is ready for use. Below the visualizer unit is a Navitar slide to video projector that is on a pull out shelf for ease of loading the carousel tray and turning the projector on. Sufficient storage space exits below the slide projector for the microphone, tape recorder and laser pointer.

The flush mounted panel on the top surface of the podium controls two podium lights, brightness and contrast for the computer monitor, audio level for the VHS player and for an auxiliary input, power and mute switch for the ceiling mounted CRT projector, forward/reverse switch for the slide to video projector and six switches to control the input to the CRT projector -- Visualizer/VHS player/Slides/PS-2 Computer/RGB1/RGB2. Auxiliary input jacks are located on the top of the side cabinet: two RGB inputs, two 1/4" phone jacks for audio taping and/or playback, and two microphone inputs. An AC duplex plug is located at the base of the side cabinet.

An added feature for ease of instructor utilization is that all components, with the exception of the Navitar slide projector, are automatically turned on when the upper podium door or the side cabinet door are opened. Both doors are wired to electrical interlock switches. There is no need to turn on individual equipment off/on switches. Due to the noise of the cooling fan on the Navitar slide projector, it was felt that this piece of equipment could be turned on only when used for slide presentations.

The audio amplifier for this ETEC classroom is not installed in the teaching station. It is recessed in a classroom wall and not accessible to the instructor. Audio levels are pre-set and the system is equalized for the classroom environment. The controls for the zoned incandescent lighting are on rheostats (each bank of lights are on its separate rheostat). Both the lighting controls and the switch for the projection screen are located on the wall directly behind the teaching station and within easy reach of the instructor.

The Appendix contains CAD drawings of the teaching station, a bid specification sent to vendors for the construction of the teaching station, and a list of equipment and components and their cost. Expenditures for equipment and components came to $38,795.00 for the Jacobs 112 ETEC classroom. The classroom rehab costs from the Physical Plant (materials and labor) came to $4,964.00.

Access and Security:

The proper security of the equipment is an integral part of these Educational Technology Equipped Classrooms. A system was devised that would help protect the equipment from vandalism, theft and unauthorized removal; yet, allow faculty designated to teach in these classrooms ease of access. Instructors have access to the equipment and systems by opening the upper door on the podium and the door on the side cabinet. Each door has a programmable combination lock set up with the same combination. The combinations are changed once a year. Electronic sensor devices are fastened on to the various components (CRT projector, computer, visualizer, etc.) and if someone attempted to remove the equipment without proper authorization an alarm would go off. Public Safety would automatically be alerted through a telephone line. As an added security precaution, these classrooms are locked after the last scheduled class of the day (around 10:00 pm) and are opened just prior to the start of the first class session (8:00 am). These classrooms are kept locked on weekends (after scheduled Saturday morning classes), holidays and during semester breaks.

Faculty Orientation:

Faculty orientation is carried out by the Associate Director - Media Resources and his staff prior to the start of classes and during the first week. A list of faculty assigned to teach in these ETEC classrooms is obtained through the School of Management. A letter and handout is sent to each faculty member explaining the ETEC program and asking them to attend one of several scheduled orientation sessions or to call and make an individual appointment.

The on-site orientation takes about one hour. The different types of media and classroom support technology are demonstrated. Access to the teaching station, calling for staff assistance and security procedures are covered as well. Discussion is encouraged and then the remainder of the orientation session is spent with hands-on. Each participant has an opportunity to open the doors (combination lock) to the podium and attached cabinet, set-up the equipment, practice using the equipment and then properly secure the equipment. Upon conclusion of the orientation session faculty are given a laminated, wallet size card with the combination to the locks. Each ETEC classroom is set-up with a different set of combinations. A Media Equipment Services staff member is also available at the beginning of the semester in the event that an instructor needs some assistance.

Concluding Remarks

The new Jacobs 112 ETEC classroom has been in use for one full semester. Although there has been no formal assessment of this new facility through a survey instrument, informal feedback points out that this classroom has been well received. Faculty are quite pleased with the placement of the Wolf Visualizer and the location of the custom control pad. The ability to display both data and video on the podium monitor has also proved to be an asset. Faculty have also remarked that the quality of the projected image (through the use of the scan doubler) appears to be better as well.

During the Winter break, an older Media Equipped Classroom will be upgraded into a Educational Technology Equipped Classroom with the redesigned teaching station. This third ETEC classroom will be used primarily by the Department of Computer Science. In addition to the teaching station, an older Macintosh IIsi will be upgraded to a Macintosh IIvx with an internal CD ROM and the GE 310 Imager projector will be upgraded to a GE 414 Imager projector. A Wolf Visualizer will be added as well. This ETEC classroom will be completed in time for the start of the 1993 Spring Semester.

New Directions:

A "Technology in the Classroom" working group has been recently formed within Academic Services, Computing and Information Technology to further explore how technology can best be developed and utilized in the classroom environment. This group will make recommendations for further development of Educational Technology Equipped Classrooms; and, look at ways in which some of the emerging technologies such as CD ROM and Digital Video Interactive (DVI) affect the classroom environment. This group, working closely with faculty, will also determine directions for development of additional ETEC software options; either to be made available locally at the teaching station, or remotely, through the campus data network.

Another challenge of this working group will be to explore ways in which the ETEC concept can be effectively incorporated in large lecture halls. A Natural Sciences and Mathematics lecture hall complex is currently under construction (five tiered lecture halls ranging from 100 seats to 385 seats and five 90 seat classrooms) and funding has been allocated for classroom technology. Plans are also underway to convert existing lecture halls to the ETEC service model as well.

The Appendix:

A variety of information is contained in the Appendix. A number of CAD drawings are offered showing the teaching station, room layout, and systems interconnection. The Appendix also contains information regarding the cost of the equipment and components, a copy of the purchase requisition and bid specifications for the custom-built teaching station, a list of the software currently used by the School of Management, and computer menu screens.

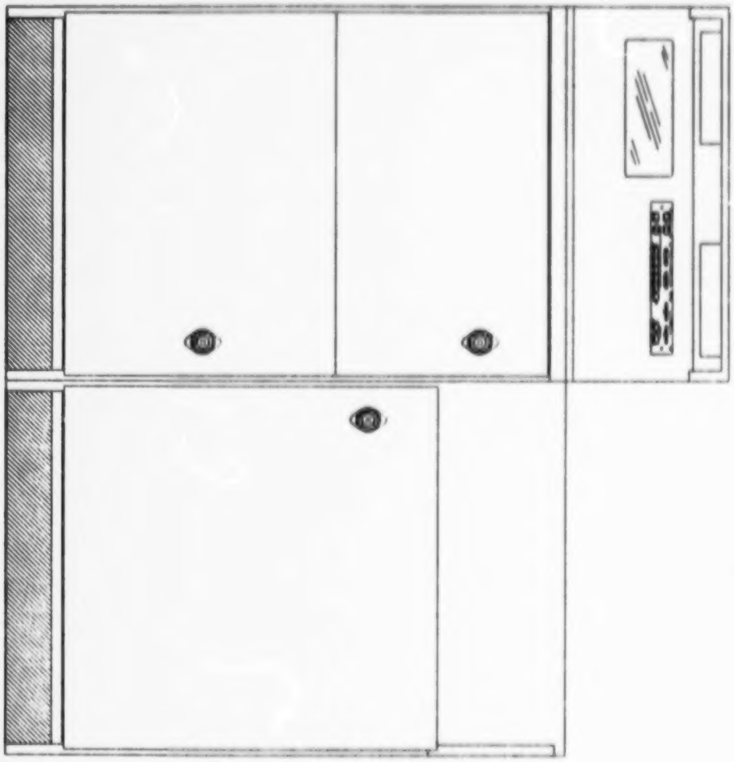
Conclusion:

In conclusion, the purpose of this presentation was to give an overview of the latest Educational Technology Equipped Classroom (ETEC) at the State University of New York at Buffalo with specific reference to the re-design of the teaching station based on faculty feedback. Although this latest ETEC classroom has only been in service for one semester, all indications are that it is been well received by the faculty assigned to teach in this facility.

Appendix

1. CAD Drawing of Teaching Station: Front View (doors closed)
2. CAD Drawing of Teaching Station: Front View (visualizer extended)
3. CAD Drawing of Teaching Station: Side View (original design vs. new design)
4. CAD Drawing of Teaching Station: Side View (dimensions)
5. CAD Drawing of Teaching Station Podium: Front View (dimensions)
6. CAD Drawing of Teaching Station Cabinet: Side View (dimensions)
7. CAD Drawing of Jacobs 112 Room Layout
8. CAD Drawing of Teaching Station Control Panel
9. CAD Drawing of Teaching Station Remote Control for Wolf Visualizer
10. CAD Drawing of Teaching Station Podium and Cabinet Work Surfaces: Top View
11. CAD Drawing of System Interconnection Diagram
12. CAD Drawing of ETEC Network Connections
13. ETEC Computer Menu Screens (main menu, software applications, Telnet and School of Management software)
14. Jacobs 112 Equipment/Cost Data
15. Jacobs 112 Teaching Station Purchase Requisition and Bid Specification

INSTRUCTORS'S VIEW, DOORS CLOSED (JACOBS 112)



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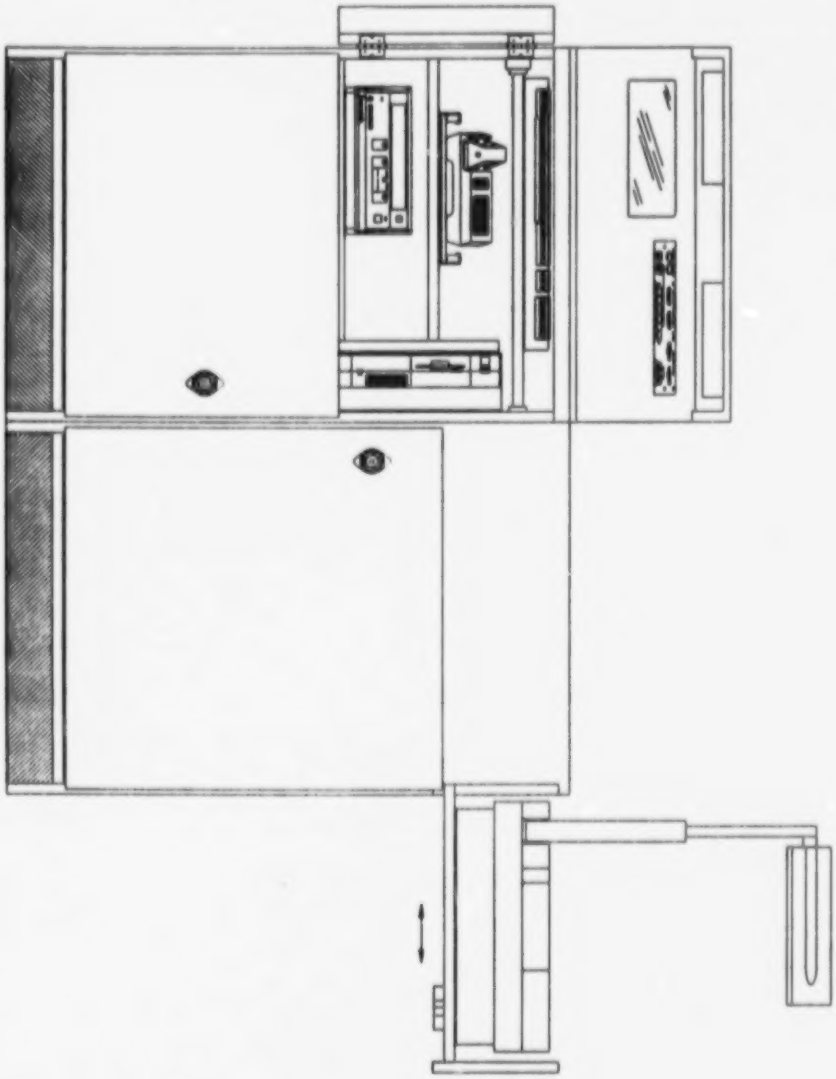
36

DWN. BY: JSG
APP. BY:
DATE STARTED: 01/27/91
LAST REVISION: 01/04/93
SCALE: NO SCALE
FILE NAME: JACV14
DISK: #
SYSTEM: ETEC-2

BUILDING/CLIENT: JACOBS
DESCRIPTION: INSTRUCTOR STATION

INSTRUCTOR'S VIEW (JACOBS 112)



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37

52

DWN. BY: JSG	**APP. BY:**
DATE STARTED: 01/27/91	
LAST REVISION: 01/04/93	
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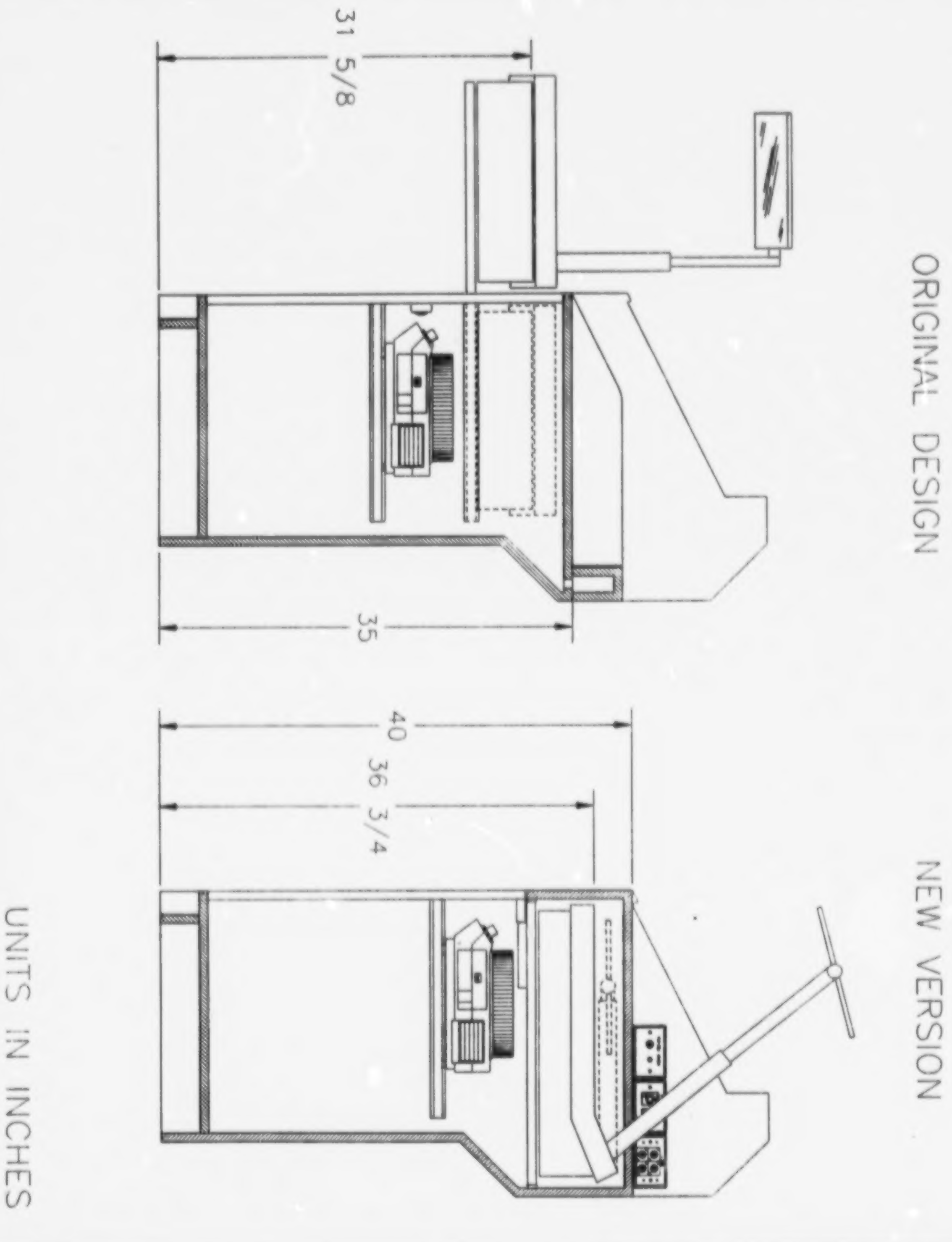
SYSTEM: ETEC-2	#

BUILDING/CLIENT: JACOBS

DESCRIPTION: INSTRUCTOR STATION


ORIGINAL DESIGN
31 5/8
35
NEW VERSION
40
36 3/4
UNITS IN INCHES

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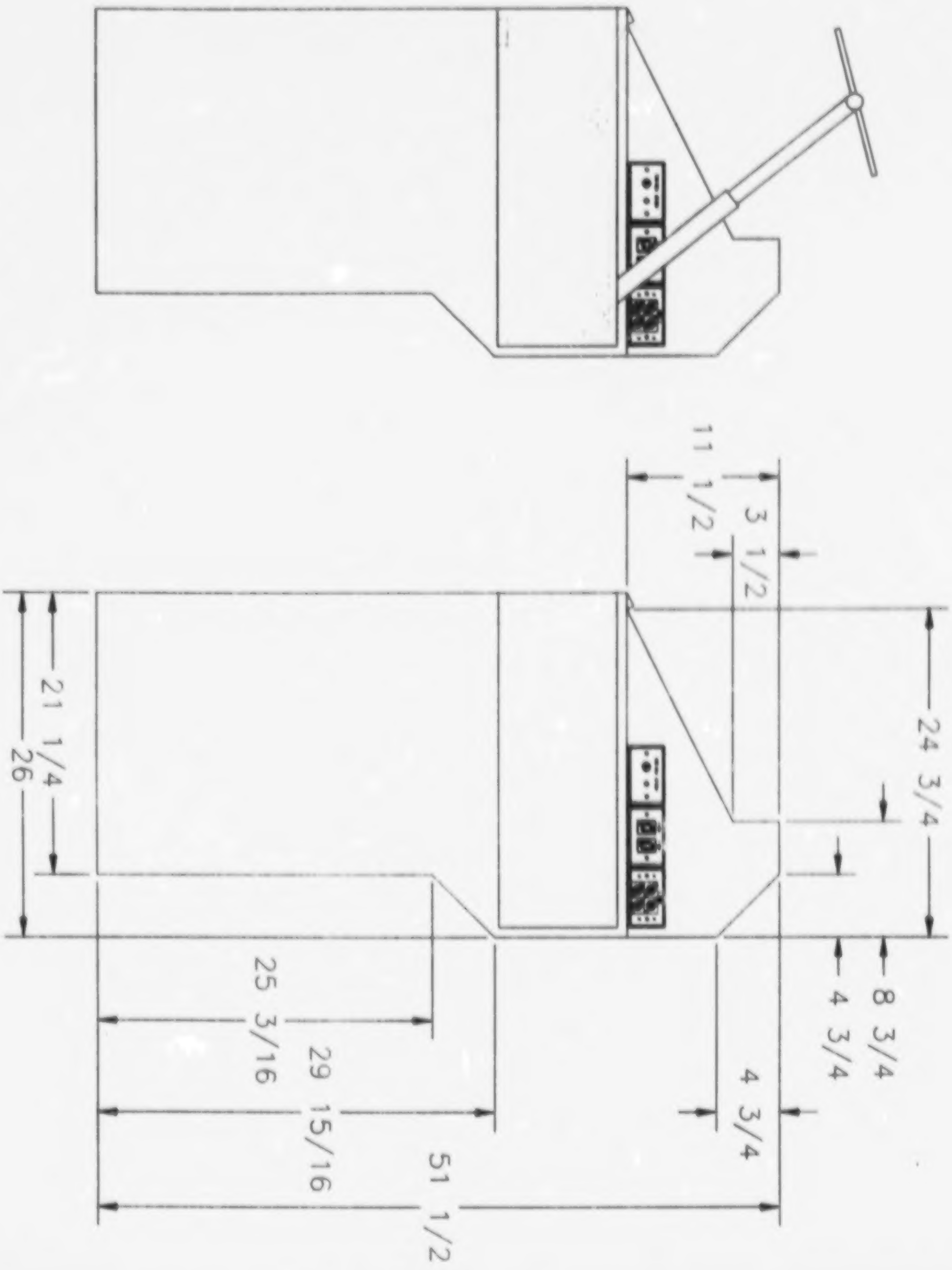
38

DWN. BY: JSG		APP. BY:	
DATE STARTED: 01/27/91			
LAST REVISION: 01/04/93			
SCALE: NO SCALE			
FILE NAME: JACV01		DISK:	
BUILDING/CLIENT: JACOBS	DESCRIPTION: INSTRUCTOR STATION	SYSTEM: ETEC-2	#

RIGHT SIDE VIEW



11 1/2
3 1/2
21 1/4
26
24 3/4
8 3/4
4 3/4
4 3/4
25 3/16
29 15/16
51 1/2

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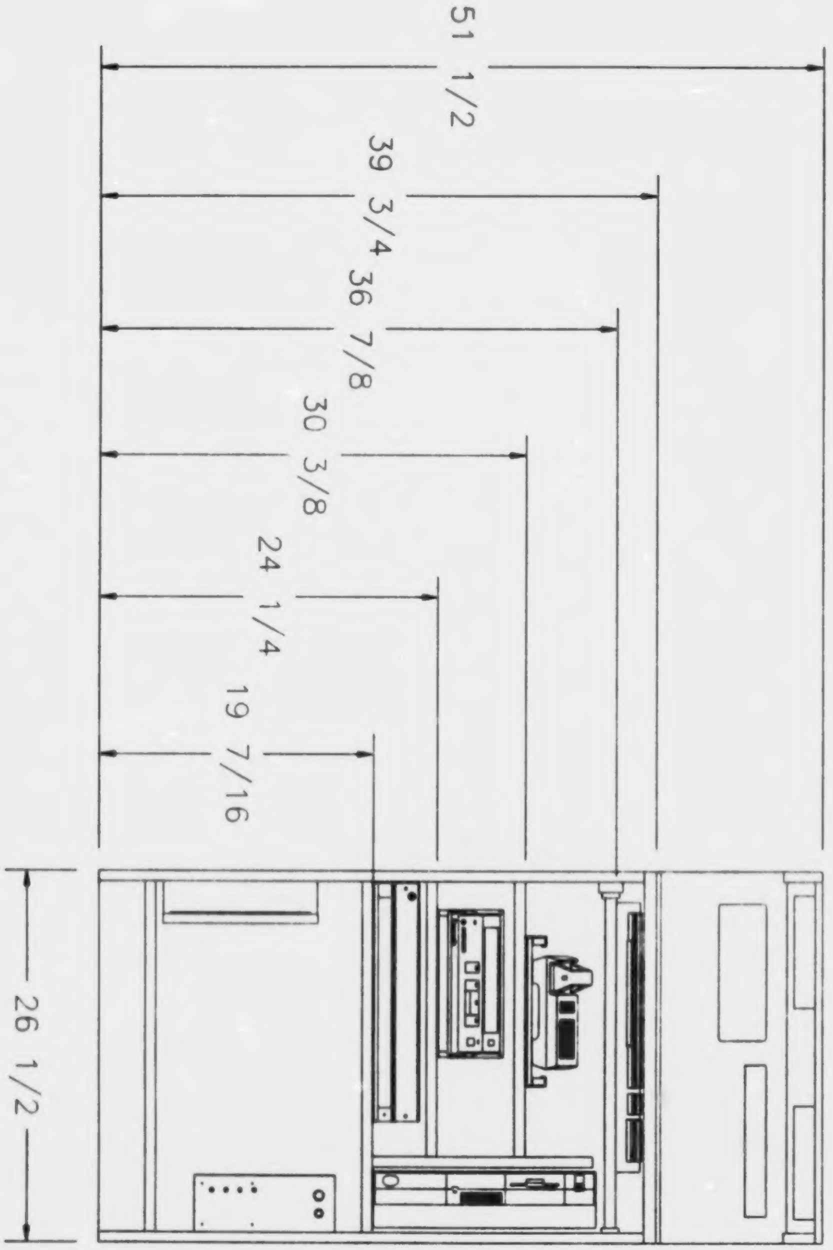
DWN. BY: JSG
APP. BY:
DATE STARTED: 01/27/91
LAST REVISION: 01/04/91
SCALE: NO SCALE
FILE NAME: JACV12
DISK:
BUILDING/CLIENT: JACOBS
DESCRIPTION: INSTRUCTOR STATION
SYSTEM: ETEC-2
#

PODIUM (DOORS REMOVED)



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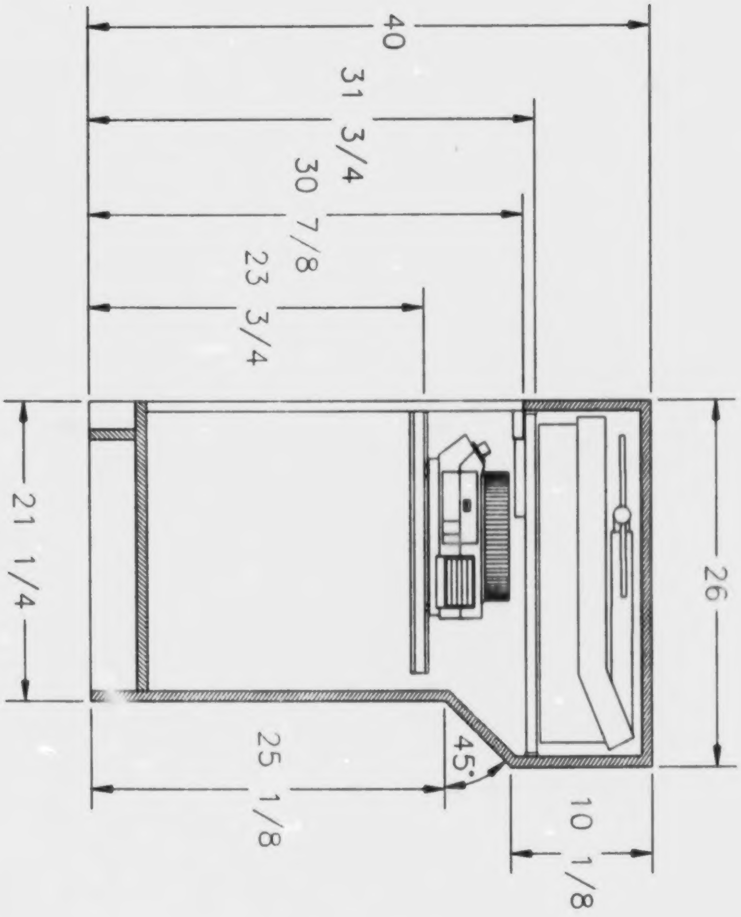
40

DWN. BY: JSG	APP. BY:
DATE STARTED: 01/27/91	
LAST REVISION: 01/04/93	
SCALE: NO SCALE	
FILE NAME: JACV16	DISK
SYSTEM: ETEC-2	#

BUILDING/CLIENT: JACOBS

DESCRIPTION: INSTRUCTOR STATION

CABINET


40
31 3/4
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23 3/4
21 1/4
26
25 1/8
45°
10 1/8

UNITS IN INCHES

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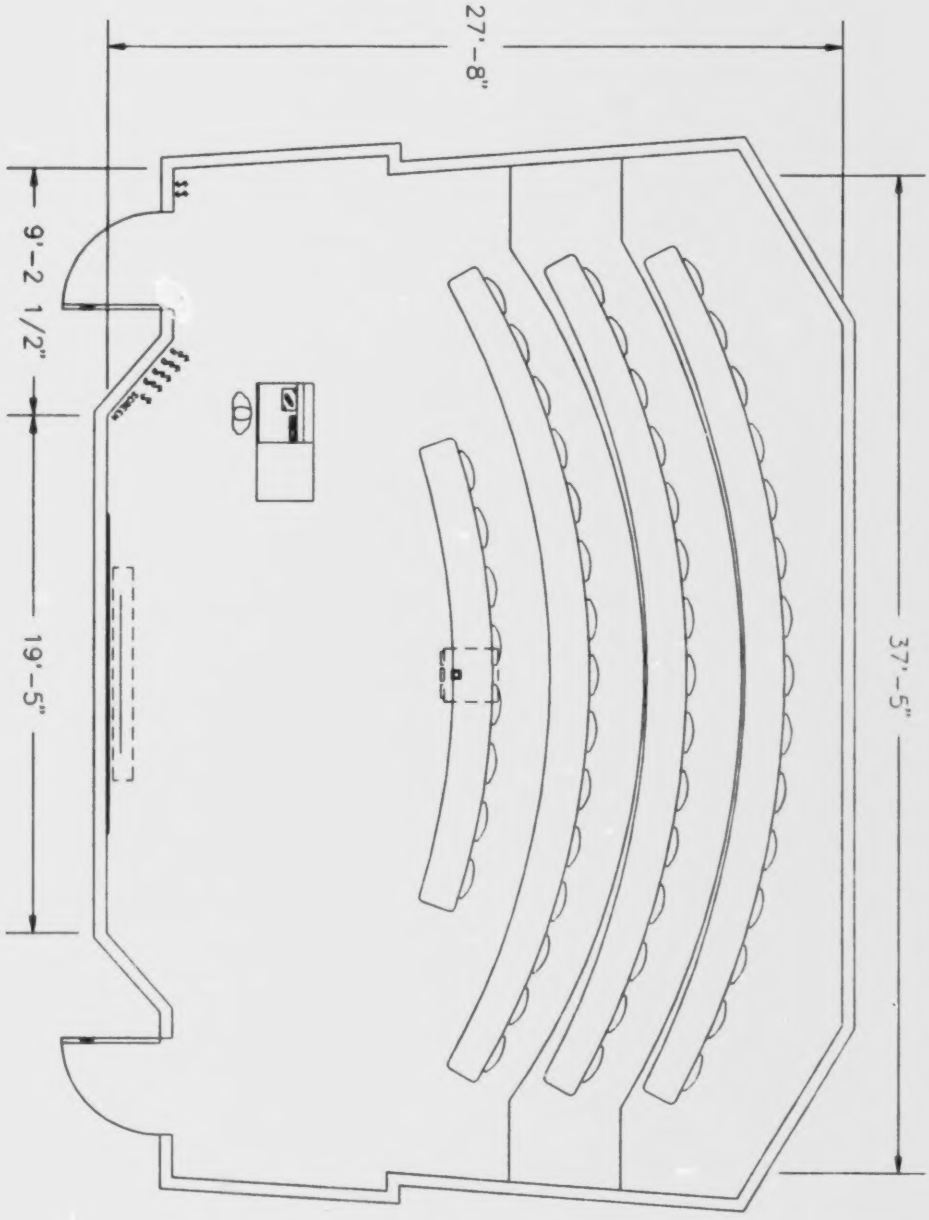
41

DWN. BY: JSG		**APP. BY:**	
DATE STARTED: 01/27/91			
LAST REVISION: 01/04/93			
SCALE: NO SCALE			
FILE NAME: JACV18		**DISK:**	
BUILDING/CLIENT: JACOBS	**DESCRIPTION:** INSTRUCTOR STATION	**SYSTEM:** ETEC-2	#



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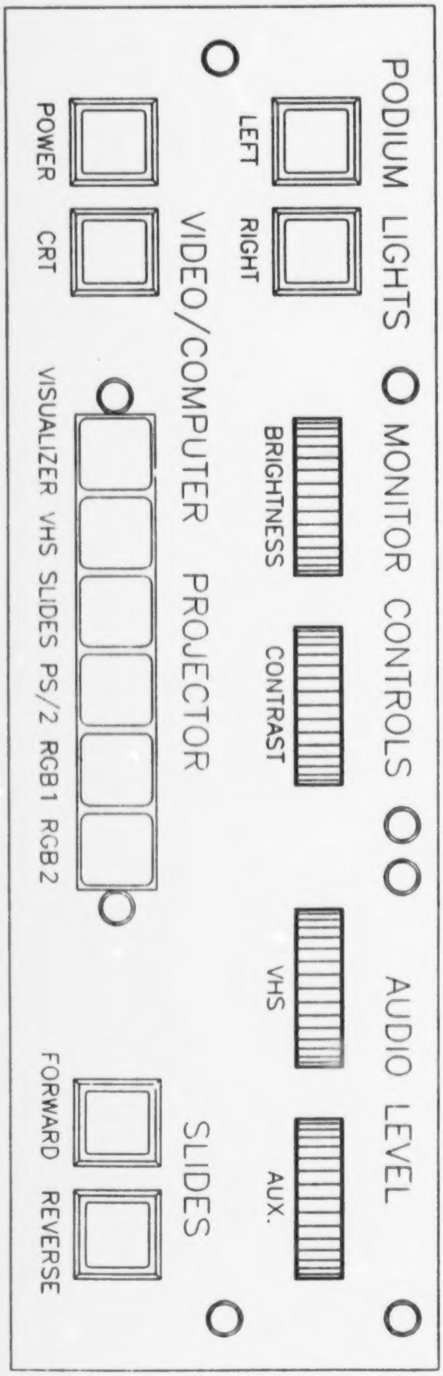
57

42

DWN. BY: JSG	**APP. BY:**
DATE STARTED: 01/27/91	
LAST REVISION: 01/04/93	
SCALE: NO SCALE	
FILE NAME: JAC112A2	**DISK:**
SYSTEM: ETEC-2	#

BUILDING/CLIENT: JACOBS

DESCRIPTION: ROOM LAYOUT


PODIUM LIGHTS
LEFT
RIGHT
MONITOR CONTROLS
BRIGHTNESS
CONTRAST
AUDIO LEVEL
VHS
AUX.
VIDEO/COMPUTER PROJECTOR
POWER
CRT
VISUALIZER VHS SLIDES PS/2 RGB1 RGB2
SLIDES
FORWARD
REVERSE

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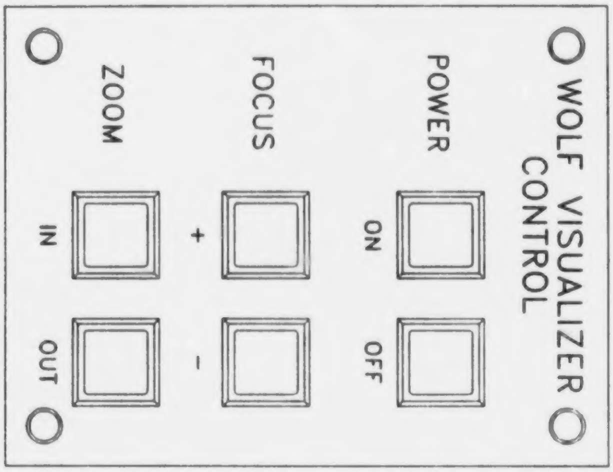
43

DWN. BY: J.S.G	APP. BY:
DATE STARTED: 07/22/91	
LAST REVISION: 12/20/91	
SCALE: NO SCALE	
FILE NAME: JACP15	DISK:
SYSTEM: ETEC-1	#

BUILDING/CLIENT: JACOBS

DESCRIPTION: MAIN CONTROL PANEL


WOLF VISUALIZER CONTROL
POWER
ON
OFF
FOCUS
+
–
ZOOM
IN
OUT

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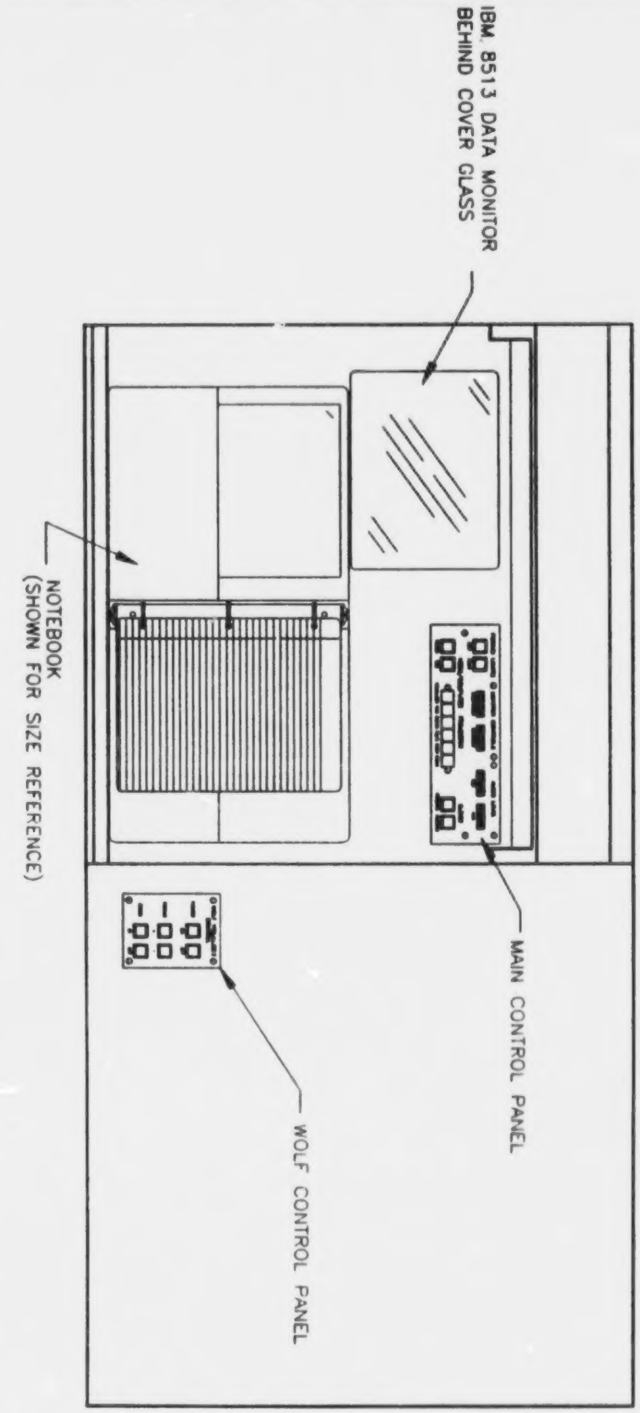
44

DWN. BY: J.S.G.	APP. BY:
DATE STARTED: 07/22/91	
LAST REVISION: 05/26/92	
SCALE: NO SCALE	
FILE NAME: JACU20A	DISK:
SYSTEM: JACOBS	#

BUILDING/CLIENT: MEC

DESCRIPTION: WOLF CONTROL PANEL

TOP VIEW OF PODIUM AND CABINET WORK SURFACES


IBM 8513 DATA MONITOR BEHIND COVER GLASS
NOTEBOOK (SHOWN FOR SIZE REFERENCE)
MAIN CONTROL PANEL
WOLF CONTROL PANEL

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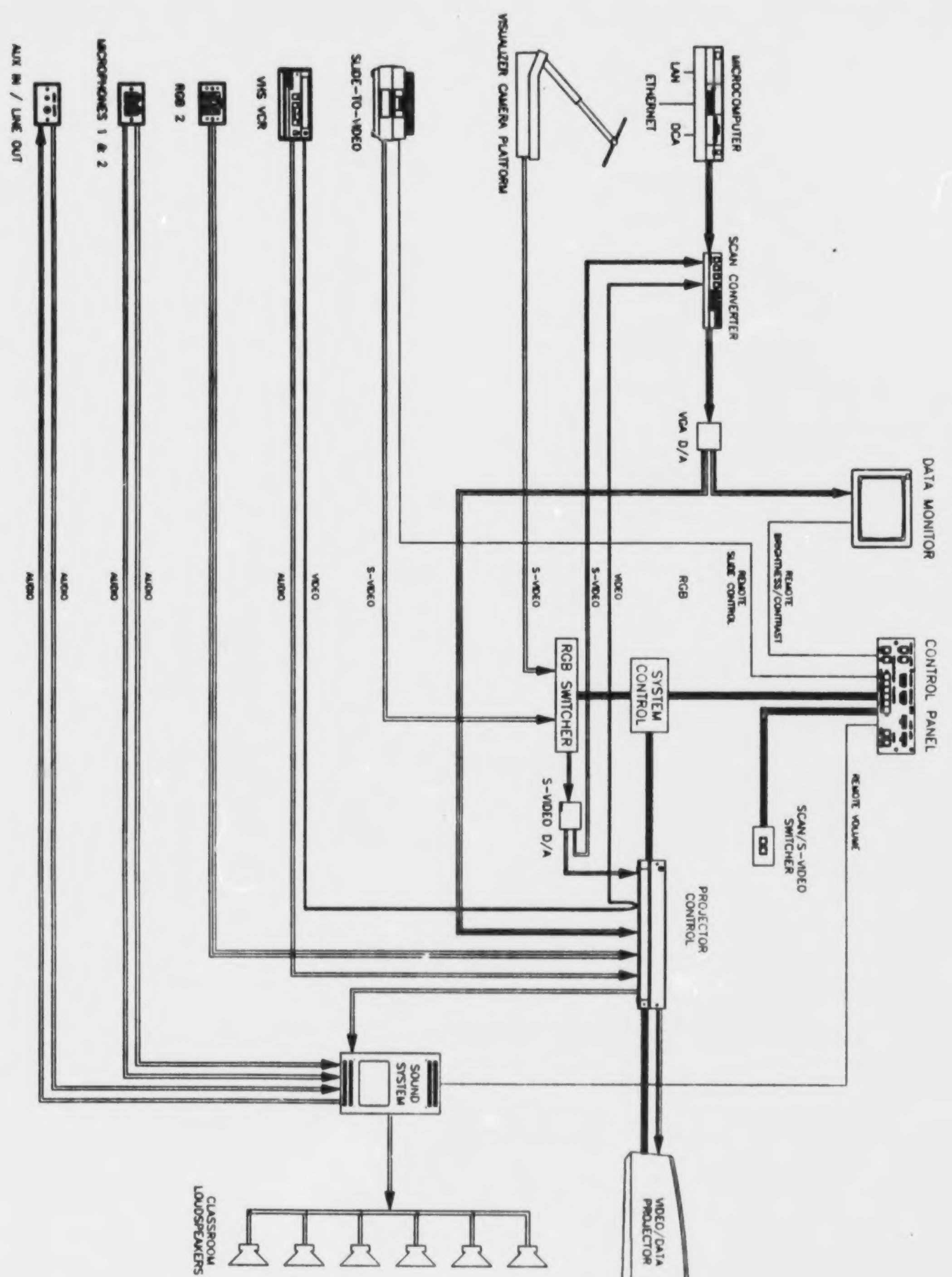
45

DWN. BY: J.S.G.	**APP. BY:**
DATE STARTED: 01/28/91	
LAST REVISION: 11/21/91	
SCALE: NO SCALE	
FILE NAME: JACP12	**DISK:**
SYSTEM: ETEC-1	#

BUILDING/CLIENT: JACOBS

DESCRIPTION: INSTRUCTOR STATION


MICROCOMPUTER
LAN
ETHERNET
DCA
VISUALIZER CAMERA PLATFORM
SLIDE-TO-VIDEO
VHS VCR
RGB 2
MICROPHONES 1 & 2
AUX IN / LINE OUT
SCAN CONVERTER
VGA D/A
DATA MONITOR
REMOTE BRIGHTNESS/CONTRAST
REMOTE SLIDE CONTROL
RGB
VIDEO
S-VIDEO
S-VIDEO
S-VIDEO
VIDEO
AUDIO
AUDIO
AUDIO
AUDIO
AUDIO
CONTROL PANEL
SYSTEM CONTROL
RGB SWITCHER
S-VIDEO D/A
SCAN/S-VIDEO SWITCHER
REMOTE VOLUME
PROJECTOR CONTROL
SOUND SYSTEM
VIDEO/DATA PROJECTOR
CLASSROOM LOUDSPEAKERS

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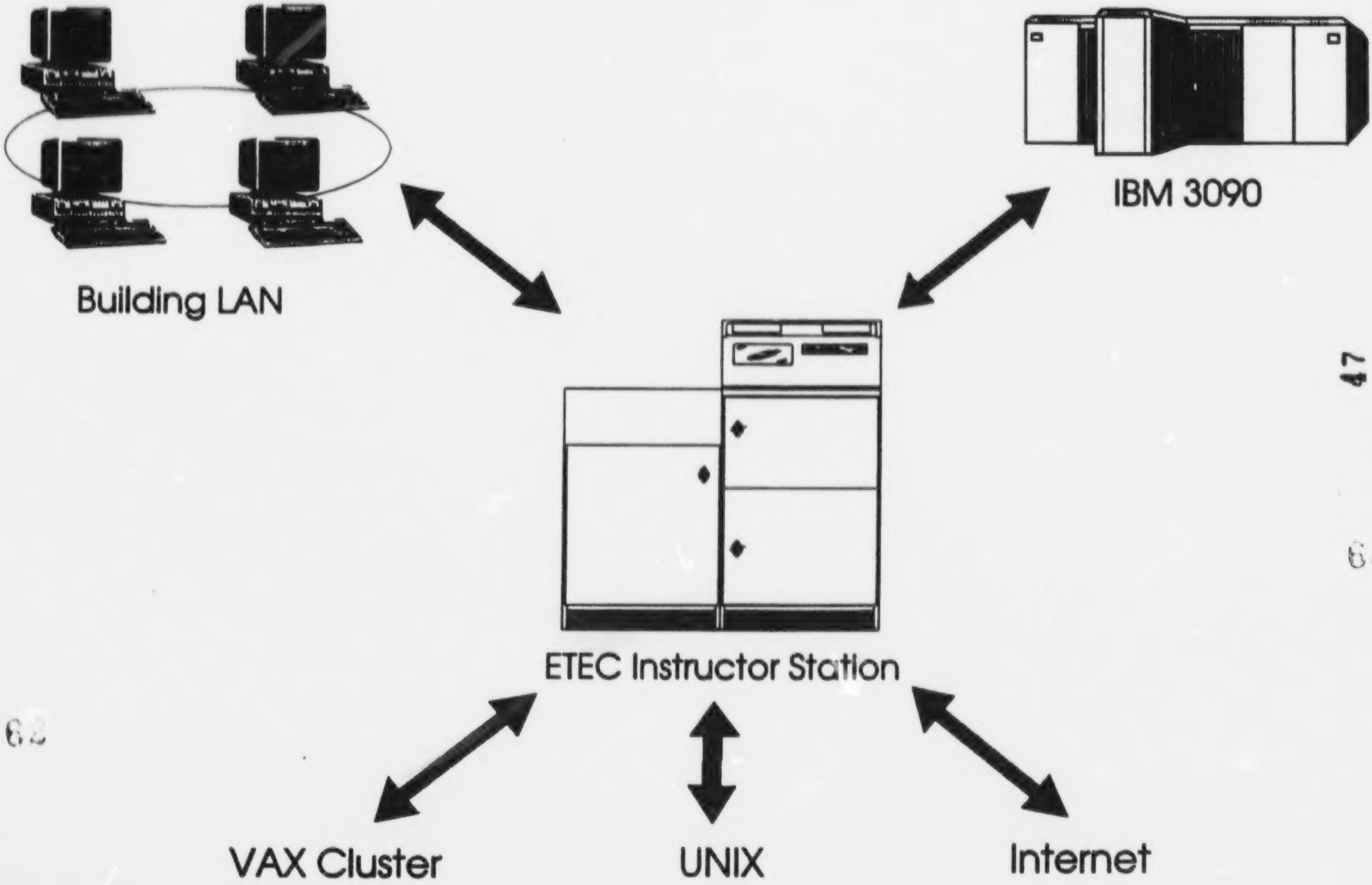
46

DWN. BY: TJC	APP. BY:
DATE STARTED: 01/08/92	
LAST REVISION: 09/16/92	
SCALE: NO SCALE	
FILE NAME: JACP13	DISK:
SYSTEM: ETEC-1	#

BUILDING/CLIENT: JACOBS

DESCRIPTION: EQUIPMENT SCHEMATIC

ETEC Network Connections



Building LAN

IBM 3090

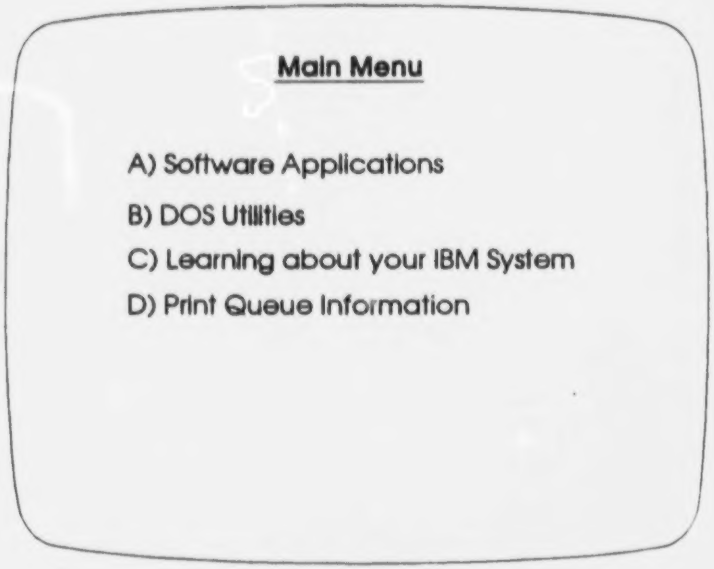
ETEC Instructor Station

VAX Cluster

UNIX

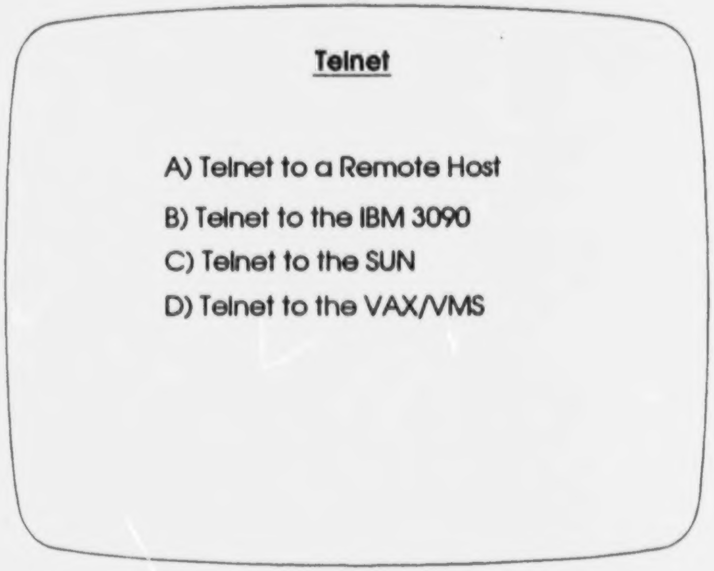
Internet

ETEC Computer Menu Screens



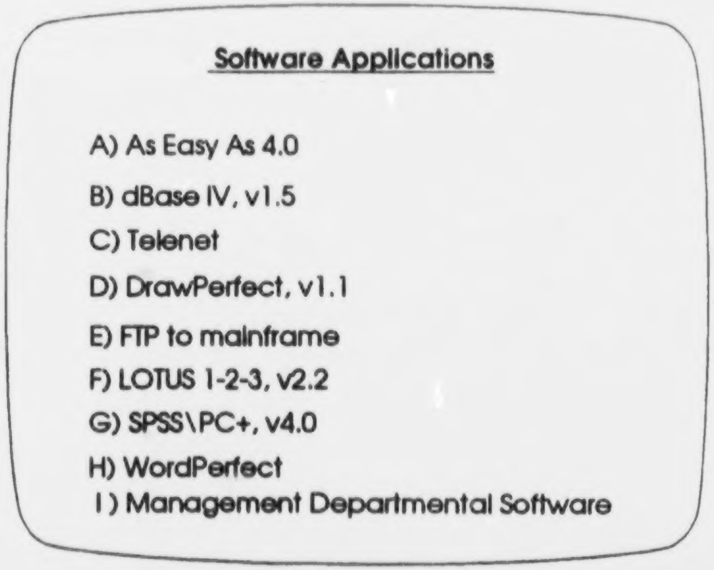
Main Menu

A) Software Applications
B) DOS Utilities
C) Learning about your IBM System
D) Print Queue Information



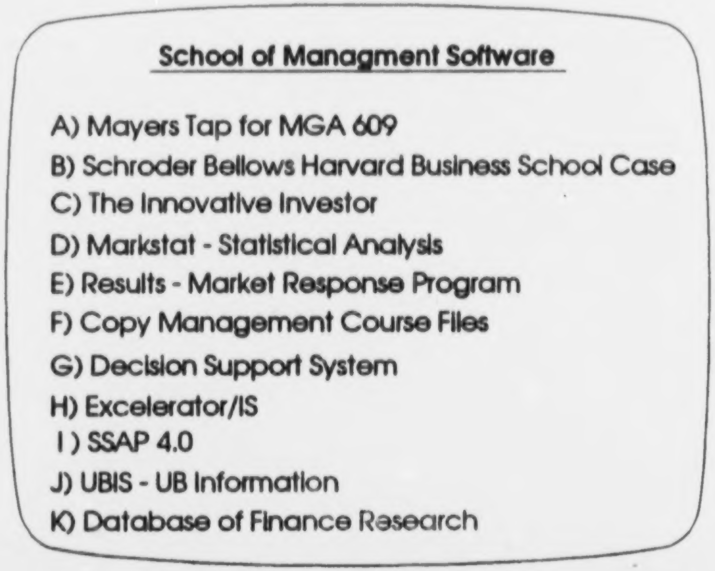
Telnet

A) Telnet to a Remote Host
B) Telnet to the IBM 3090
C) Telnet to the SUN
D) Telnet to the VAX/VMS



Software Applications

A) As Easy As 4.0
B) dBase IV, v1.5
C) Telenet
D) DrawPerfect, v1.1
E) FTP to mainframe
F) LOTUS 1-2-3, v2.2
G) SPSS\PC+, v4.0
H) WordPerfect
I) Management Departmental Software



School of Managment Software

A) Mayers Tap for MGA 609
B) Schroder Bellows Harvard Business School Case
C) The Innovative Investor
D) Markstat - Statistical Analysis
E) Results - Market Response Program
F) Copy Management Course Files
G) Decision Support System
H) Excelerator/IS
I) SSAP 4.0
J) UBIS - UB Information
K) Database of Finance Research

Jacobs 112 Equipment/Cost Data

	Equipment and Components	Amount
1.	Teaching Station	$ 3,800.00
2.	G.E. #414 Video/Data Projector	8,790.00
3.	Video/Data Projector Ceiling Bracket	537.17
4.	Switcher, Distribution Amp, Cables	1,476.50
5.	S-Video Components	819.62
6.	InLine IN1222 Scan Doubler	2,436.00
7.	PS/2-55SX Computer, 8513 Monitor	2,337.00
8.	G.E. Wolfe Visualizer	6,870.00
9.	Panasonic AG-1000B Video Cassette Player	506.78
10.	Navitar Videomate 2000	3,604.00
11.	Sound System Items	4,397.60
12.	Laser-X LDP-5AV Pointer	410.00
13.	Auto Dial Telephone	170.03
14.	Electronic Alarm System and Accessories	192.17
15.	Projection Screen Fabric and Tension Bar	178.76
16.	Cable and Custom Built Items	1,798.00
17.	Electrical and Miscellaneous Supplies	471.20
	Total	$ 38,794.83

PURCHASE REQUISITION
STATE UNIVERSITY OF NEW YORK
AT
BUFFALO

REQUISITION
№ 949488 S

PURCHASE ORDER NUMBER

VENDOR RABCO DESIGN, INC.
STREET 8925 SHERIDAN DRIVE
CITY & STATE CLARENCE, N.Y. 14031, 631-3010
FEDERAL I.D. #

REQUISITION DATE
STATE CONTRACT # GROUP #
ACCOUNT NUMBER
FACILITY SCH. OF MANAGEMENT, JACOBS 112 PROJ.
DEPARTMENT EDUCATIONAL TECHNOLOGY SERVICES
ATTN: WM. MAIMAN
SHIP TO BUILDING WENDE ROOM NO. 318
REQUESTED DELIVERY 6/17/92

THIS IS NOT A VENDOR'S ORDER

INSTRUCTIONS:

1. MAKE SEPARATE REQUISITION FOR EACH VENDOR AND COMMODITY GROUP
2. ATTACH ALL LETTERS, QUOTATIONS, AND OTHER APPLICABLE PAPERS TO THIS REQUISITION.
3. FORWARD THIS REQUISITION TO THE PURCHASING AGENT
4. USE DOUBLE SPACE ON ITEM ENTRIES

F.O.B.	SHIP VIA	TERMS	BUYER
☐ DESTINATION ☐ SHIPPING POINT ____ CITY			

Item No.	Description of Material/Service	Quantity	Unit	Price	Amount
	AUDIO VISUAL INSTRUCTOR STATION				
1	CONSTRUCTION OF CUSTOM INSTRUCTOR STATION CONSISTING OF SEPARATE PODIUM AND CABINET SECTIONS FOR JACOBS 112 BASED ON DESIGN OF JACOBS 110 AND FEATURING VARIOUS CHANGES. ALL CABINETRY HARDWARE TO BE PROVIDED UNDER THIS ORDER MUST BE REVIEWED AND APPROVED BY UNIVERSITY PROJECT COORDINATOR. EQUIPMENT ITEMS AND CONTROL PANELS REFERENCED IN THE ENCLOSED ATTACHMENTS ARE NOT TO BE CONSIDERED PART OF THIS ORDER. ALSO TO BE PROVIDED UNDER THIS ORDER ARE FOUR (4) FULL WIDTH ADJUSTABLE SHELVES AS ACCESSORY ITEMS. ALL DRAWINGS AND CONSTRUCTION NOTES ENCLOSED AS ATTACHMENTS TO THIS ORDER ARE FOR REFERENCE PURPOSES ONLY. CONTRACTOR IS REQUIRED TO COMPLETELY REVIEW AND ASCERTAIN ALL CONSTRUCTION REQUIREMENTS AND DIMENSIONS WITH UNIVERSITY PROJECT COORDINATOR PRIOR TO BEGINNING CONSTRUCTION.	1	EA		3,800 00
	PAYMENT PLAN: A PARTIAL PAYMENT PLAN CONSISTING OF 60% PAYMENT AFTER COMPLETION OF CABINET (WITH LAMINATE) AND REMAINDER PAYABLE AFTER COMPLETE INSTALLATION IN JACOBS 112 CLASSROOM.				
	PLEASE NOTIFY WM. MAIMAN AT 831-3761 IF THERE WILL BE A DELAY IN SHIPMENT OF THIS ITEM(S).				

PLEASE CHECK APPROPRIATE BOX/BOXES
☐ MINORITY-OWNED BUSINESS ☐ SMALL BUSINESS (UNDER 100 EMPLOYEES) ☐ HANDICAPPED ☐ WOMEN-OWNED BUSINESS
SOLICITED MBE ______ WBE ______

IN ACCORDANCE WITH ☒ TELEPHONE FAX ☐ WRITTEN QUOTATION BY BOB BARONE DATED 4/16/92 OUR REF NO

PO/Contract	Line	Act	Amount	Dept	Cost Center	Var	Yr	Object

FUNDS AVAILABLE BY

DATE

SUNY ACCOUNT	SUB	OBJECT

50 67

White: Purchasing Copy
Pink: Requisitioner - Detach and keep

REQUESTED BY TELEPHONE NO

AUTHORIZED SIGNATURE

Custom Instructor Station Construction Notes

1. Podium and Cabinet to be constructed and finished as separate, standalone items.
2. Podium and Cabinet to be 3/4" heavy-duty industrial grade-dense particle board construction; finished all exterior and inside sides with Formica brand #118 Finnish Oak (or equal) laminate.
3. Podium keyboard shelf, and top two Cabinet shelves, to be on slide-out rails capable of supporting 150 lbs. All other shelving to be adjustable (32mm system), and perforated to facilitate airflow. Shelf cutouts required for wiring access.
4. All doors fitted with 3 hinges allowing doors to be opened a full 270 degrees. All doors to also include matching combination locks. Locks to match type installed in Jacobs 110.
5. Podium monitor compartment to be constructed to accommodate either an IBM 8513 or IBM 8515 monitor. A monitor mounting configuration is required which will accommodate either monitor model, and allow monitor positioning adjustment. Monitor mounting configuration to match existing Jacobs 110 configuration.
6. Podium work surface to be constructed with flush-mounted safety glass panel over the monitor areas; and, a surface cutout for a flush-mounted system(s) control panel. Cabinet work surface to be constructed with a surface cutout for a flush-mounted system(s) control panel.
7. Provisions must be made in the construction of both the Podium and Cabinet sections to permit vertical airflow and equipment ventilation. Provisions also must be made to allow for the mounting of recessed Wiremold type electrical boxes.
8. Bottom panels in both the Podium and Cabinet constructed so as to be removable, or to provide access to the base area for ease in connection of system(s) wiring.
9. Slide-out platform to be provided for Campus Telephone.
10. Cabinet connector panel constructed so as to be removable.
11. Separate 2" x 4" (nominal) floor mounting frame, to be provided for both the Podium and Cabinet to facilitate installation and reinforcement for anchoring hardware.
12. Progress Meetings shall be scheduled with the Project Coordinator, Wm. Maiman, 831-3761, to review progress and allow for custom fitting of equipment.

Title:

Foundations Symposium: A Continued Dialogue on Critical Theory, Cultural Analysis, and Ethical Aspects of the Field

Chair:

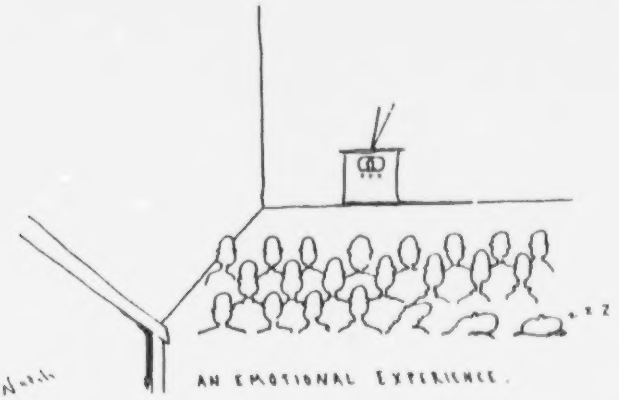
J. Randall Koetting

Authors:

Jane Anderson
Denis Hlynka
Al Januszewski and Elisa J. Slee
J. Randall Koetting
Robert Muffoletto
Randall G. Nichols
Andrew R. J. Yeaman

FOUCAULT AND DISCIPLINARY TECHNOLOGY

"Where the sun lights up the swift joys of deprived animals."
...Baudelaire



Crisis of representation ("Let X equal X". Laurie Anderson), crisis of authority ("Your gaze stops on the side of my face." Barbara Krugar), crisis of subjectivity (Photographs of Cindy Sherman dressed up as many different women subjects. Who is the real Cindy Sherman?). Politics of the observed, politics of the observer (Van Maanen, 1988; Lather, 1991). The post-modern condition (Lyotard, 1984) necessitates that what claims to be real, true, universal, and timeless, may in fact be partial, time/place bound, incomplete and socially constructed (Toulmin 1990, Rorty, 1989). Kuhn writes about "paradigm shifts", Rorty about "historical contingencies, Foucault about "epistemes" and discourses, and Wittgenstein about "language games". As we draw to the end of the 20th century all that was understood to be true is up for question. Rather than seeking Truth, we are now encouraged to seek little truths which are situationally appropriate.

For Michel Foucault, it is important that we question everything, including law, science, religion, and Western philosophy. An ironic stance, disciplined thought, and practical wisdom helps people invent themselves, rather than being concerned with finding themselves. Foucault believes in reason, but he believes that it is important to place limits on reason and realize that there are times when humor, the imagination and the acceptance of contradictions co-existing can help people develop a healthy attitude about living in this world. Rather than calling for unifying around a project, such as Habermas's emancipatory project, Foucault suggests accepting a society of difference and the developing of a ethos ("Life as art." Baudelaire). For Foucault, rather than being concerned with using language for converging on a concept of community, language should be used to open up possibilities.

Foucault works with what he calls methods of archeology and genealogy: he studies current conditions, tries to determine what has allowed these conditions to develop, and then opens up possibilities of new ways of looking at these issues. A focus in his study is the relationship between power and knowledge. For Foucault, those who seek and maintain power over others frequently use three **disciplinary technologies** which shape people into accomodating, docile bodies:

a. **Surveillance** - ordering bodies in space and time so that can can easily be observed or think they are being observed.
b. **The Examination** - testing people so that they can be compared with others in a group, while also be further individualized.
c. **Normalizing judgement** - convincing people of correct action, thoughts, and truth.

Some questions concerning educational technology which emerge from my reading of Foucault include:

a. Should we, as educational technologists, be concerned with how we position the whole bodies of the teachers and students?
b. How can materials which aim at reliability, replicability, algorithmic decision making, control and quantitative evaluative measures develop the critical thinking capabilities of a person?
c. Are there appropriate sites and non/sites for educational technology? If so, how do we determine appropriateness?
d. What is our theory of instruction? Do we aim to teach students what they should learn, or do we aim to teach students how to learn?
e. Is one of a teacher's responsibilities making students comfortable with receiving directions and trusting information which comes from technology?

Foucault, M. (1979). **Discipline and punish** (Alan Sheridan, Trans.). New York, NY: Vintage.

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Paradigms Reframed: Constructivist, Post-industrial, Modern or Postmodern Educational Technology ?

by Denis Hlynka
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There is some confusion and some reluctance to accept the term "postmodern" within mainstream educational technology. Opponents argue that it is too vague a term, too slippery, too literary, too negative, or just plain inappropriate. Proponents argue otherwise.

"Modernity" reflects an almost scientistic belief in the progress of the twentieth century. Yet others argue that modernity did not deliver all that it promised. That questioning attitude towards the thrust of modernism is a post-modern view.

There seems to be less concern less trouble when the noun is "industrialization." We have, likewise moved beyond the "industrial" revolution, beyond our fascination with the machine as saviour, towards what has been dubbed a "post-industrial" world view, one in which the benefits of industrialization are accepted, but critically.

Psychology, for many the root metaphor for educational technology, has also made a similar move. The Behaviorist model led to the cognitivist. Today, constructivism is seen as a next step in the cognitivist road towards understanding how we understand. And what we are beginning to understand is that reality is not always just there, but like mathematics, technology and religion, it is a human construction.

The field of Artificial Intelligence has made similar shifts. A post- "artificial intelligence" era confronts reality and non-reality with "virtual reality." But virtual reality is not merely a science fiction concept in which one seems to step inside one's computer world. A virtual library is one in which all the books of the world are available to you, via simple technologies of data-base searching, electronic mail, and interlibrary loan services. A virtual classroom is one which is tied in to the entire world through electronic technologies.

All of the above are examples of the same "megatrend". Concentration on the "technical" is not enough. That provides a one-sided view of reality. Even culture, in a shrinking global village is becoming an ironic post-cultural phenomenon. In short, we need to be post-cultural; we need to be post-cognitive; we need to be post-industrial; we need to be poststructural; we need to be post-aesthetic. And the word which captures all of that is "postmodern."

Bibliographic Comment

The following entries represent some of the many writings which suggest a move away from the concept of modernity:

Saul, J. R. (1992). **Voltaire's Bastards: The Dictatorship of Reason in the West.** Saul pinpoints Voltaire as the beginnings of the rational order, the age of reason. But, Voltaire's followers bastardized his ideas and his ideals. Reason and rationalism don't work when led by bureaucrats and technocrats. And that is precisely what modern society has become. As one reviewer has put it, "John Ralston Saul wants to persuade us that real enlightenment lies not in the modern cult of Answers, but in the stubborn, sceptical and humane pursuit of Questions."

Barrett, William (1986). Death of the Soul: From Descartes to the Computer. Barrett identifies the seventeenth century as the beginning of modernism and in particular, modern science. While the early philosopher was equally at home in matters of science and soul, contemporary philosophers have become pre-occupied with data and information. What has been lost is a philosophy of mind, of morals, of the soul. If Nietzhche has argued that "God is dead", Barrett shows that it is us, that is our soul, that is dead.

Nisbet, R. (1980). History of the Idea of Progress. Writes Nisbet: "Faith in the dogma of progress is waning rapidly in all levels and spheres in this final part of the twentieth century...[The reason is the] erosion of all the fundamental intellectual and spiritual premises upon which the idea of progress has rested throughout its long history." (p. 9)

Foundations and Technology in Education: A new area of study within the AECT?

Al Januszewski & Elisa J. Slee
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Our purpose in writing this paper is threefold: first, we would like to describe what it is that we think that those who affiliate with this "alternatives group" are interested in doing; second, we would like to show that a large number of these individuals study in an area of education that is commonly known as educational foundations; third, we would like to outline some of the ideas and considerations that would be involved in the creation of "Division of Foundations" within the AECT.

Admittedly, we are relative newcomers to the AECT. We are somewhat unclear as to what all this talk of 'alternatives' is about. It was a label that seemed to be in place when we arrived, and so, perhaps a little grudgingly, we will use it.

What *are* the individuals in the alternatives group interested in doing? The term alternatives group is perhaps a misnomer. After all, the word alternatives implies a certain degree of relativity, that is, it is an alternative to something. The AECT, as the mouthpiece of the field of educational technology, has, for some time, tried to define the field with/for some sort of clarity. The difficulty that the AECT has had in successfully completing this task (defining the field of educational technology) makes it equally difficult to define an alternative to it.

You can however, try to describe such alternatives in terms of function. That is you can show a little about how things differ from the mainstream of current study being done in the field of educational technology. Broadly speaking, those that affiliate with the alternatives group seem to differ from mainstream educational technology research when they conduct their studies by at least one of the following forms:

- they use different theoretical bases
- they use different research methodologies
- they ask different sorts of questions

Like others that study in the field of educational technology, the folks in the alternatives group both pose, and try to answer, questions of "how to?" One of the ways in which the members of the alternatives group can differ from the "traditional" investigators of educational technology is that they may start with a different theoretical base. Here's an example: How would we design instruction without task or hierarchical analysis? This question would emanate from a different theory base because it would challenge some of the basic practices of our field, namely that task or hierarchical analysis is even appropriate.

Another way in which the members of the alternatives group may differ is in the research methodologies employed to collect information. For example, members of this group are particularly interested in exploring conceptual and qualitative research methods (another concept that seems to defy consensus meaning) in their investigative efforts.

The questions that are posed by members of this alternatives group can also differ significantly from those that are asked by AECT members that are studying educational technology. One example revolves around the seemingly very simple question, "Why should we do something?" (Such as recommend a particular instructional intervention.) Often, traditional educational technologists might recommend a particular practice and then study the idea of this particular intervention to see if it "works". Conversely, many of those involved in the alternatives group would study the action or intervention to see if it is "right" or "good." In this case a conscious effort would be made to differentiate between an idea that "works" and an idea that is "right or good." The thought is that the two ideas are simply not, a priori, the same. An idea that "works" in a given situation is not, de facto, "right" or "good" for it. The emphasis for this sort of question is less on the 'technical' (How can we do it?) and more on the 'moral' (Should we do it?) and the 'political' (What would it mean for our greater good?).

Another distinction that might be made, by virtue of having reconstructed the "why" question, is that traditional educational technology research seeks to answer questions and solve problems. The alternatives group seems to be interested in posing questions and finding problems.

Specifically, the areas of research of interest to the members of the alternatives group seem to lie in the arenas of philosophy, qualitative methods, history, sociology and cultural studies, in addition to the more traditional areas of interest such as psychology, communications, and teacher education. It is important to note that most of these areas of research interest are, more often than not, considered as part of programs that are called "cultural foundations of education", or "social foundations of education", or simply, "foundations of education."

It is not the case that all of the work that is done by those that affiliate with the so called "alternatives group" within the AECT falls into the category that is referred to as educational foundations. Neither is it the case that all of the work that is done in the area of educational foundations at the AECT is done by those that affiliate with the so called "alternatives group". There is, however, an area that is common to both that is undeniable and unmistakable.

Within the realm of educational technology, foundations seems to have taken (or been given) a back seat. Instead, our field has focused upon systems and technology with an increasing emphasis on micro technologies (hypercard, etc.). So, the alternatives group might be said to be a group of individuals interested in some of the broader issues with which educational technology can be concerned. For example, educational technology and its relationship to curriculum construction or its impact on society and culture in general.

So, why form a separate division? One answer is that we do this sort of work anyway. At present, the members that might comprise such a division are scattered amongst the other nine divisions, often a unheard voice in each. Often, unless by some chance meeting, perhaps at one of the AECT receptions, the opportunities to exchange common ideas and perceptions on these sorts of issues are rare. In fact, the opportunities for intellectual exchange can be so rare that we may lose many of these individuals to other, more traditional associations such as American Educational Research Association. There, the individuals in AECT's "alternatives group" may find themselves more comfortable in an organization which has a large membership studying similar things.

Why should we run the risk of losing these individuals to the larger organizations? Can't their contributions influence the AECT and help us to consider broader issues that will only improve our pursuits as a field? AECT has taken a step in this direction. It established, several years ago, the Annual Open Forum on the Foundational Issues of the Field. .This is an annual session at the national AECT conference. While this forum provides an arena for some exchange, it needs to be supplemented by additional sessions to increase the opportunity for discussion on related topics.

Finally, a study of history will show that some of the best advances in a field arise when its membership takes the time to reflect upon and evaluate the field's growth. A "Division of Foundations," while engaging in ethical review and the recording of history, might also undertake this effort, on a regular basis. The results of this self-evaluative effort could inform the membership in all divisions of the AECT.

With what would a "Division of Foundations" within the field of educational technology be concerned? Some of the topics would include: the field and its history, social concerns, and research. Issues that are central to the discussion of the field are personnel certification, competencies and roles; legal and ethical issues; and the status, definition, and future of the field. For example, it would be useful to examine the status and future of the field, as well as its relationship to other fields such as psychology.

Issues that are central to the discussion of social concerns include the relationship of technology to education, the impact of technology on culture and issues of equity involved in the use of educational technology. An example of such a social concern would be the unintended effect of computer based instruction on social interaction.

Issues that are central to the discussion of research include the purpose of the research, the methodologies that are employed and the setting of the research study. Those in the "Division of Foundations" that were interested in research might reflect upon the type of research we conduct as a field. How does it differ from that conducted in psychology? communications? Should it differ? Are we making progress in our research as a field? Because of the practical nature of educational technology, should all of our research necessarily be conducted in applied settings? What research methods should be employed? The purpose of a creation of a "Division of Foundations" is not meant to centralize and control the discussion of each of the above activities. Rather, we acknowledge that the potential member of such a division might also be active in other divisions of the AECT. It is our opinion, however, that the proposed division would provide a means for linking individuals interested in pursuing similar lines of investigation. And, exploring these topics as an organized membership, individuals would be able to inform members in other divisions of their findings which would undoubtedly guide future research and development in all divisions.

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Post-modern Thinking in a Modernist Cultural Climate:
The Need for an Unquiet Pedagogy

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A working paper of ideas for the
Open Forum, Foundations Symposium:
A Continued Dialogue on Critical Theory, Cultural Analysis
and Ethical Aspects of the Field
Association for Educational Communications and Technology
Research & Theory Division
New Orleans, LA
January 17, 1993

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Post-Modern Thinking in a Modernist Cultural Climate: The Need for an Unquiet Pedagogy

> A pedagogy is that much more critical and radical the more investigative and less certain of "certainties" it is. The more unquiet a pedagogy, the more critical it will become.
>
> Paulo Freire

All educational activities are political in nature. The act of teaching itself is a moral activity, because teachers intervene in the lives of their students.

To view schooling within a political/ethical context suggests the need for research and analysis that would include but not be limited to, an examination of the following: the non-neutrality of educational institutions, and hence the connectedness of knowledge and power; a critical analysis of current meanings and the "official discourse" of schooling within sociocultural agendas; visions of society that are oriented toward social justice and community; and having the tools/conceptual framework and language of research that allows for the multiple and complex forms of schooling that we experience.

The above commentary suggests that we need to be concerned with the "foundational" issues of schooling. By foundational I mean those issues that raise questions about the very nature of educational experiences. In raising questions about the nature of the schooling experience, we are confronted with contradictions. The contradictions are present not only within the schooling experiences, but in our day to day experiences of social life.

Contradictions/Uncertainties of Schooling

Why is it that educators find themselves with the best tools/technologies/testing procedures/organizational models, i.e. the best that modernist thinking has to offer, yet they are unable to impact the postmodernist world of their students? The mainstream framework for explaining life in schools, what life in schools should be like is a modernist concept rooted in predictability and control. School reform is seen as fine tuning the system, hence incremental rearrangement of school practices is seen as substantive change. Yet living in school is not programmable. Living in school is living in conflict (if "real" learning is going on). Living in school is living on "contested terrain" (if "real" learning is going on). Working through the conflict, struggling and negotiating meanings on the contested terrain, can leave one unsettled, experiencing a feeling of "chaos". Hence unsettled feelings, experiehcing feelings of chaos, are part of the human condition.

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Not far removed from this experience of living in schools are similar experiences of "being in the world". We find ourselves in social settings that are "supposed to make sense", that are supposed to be predictable, that are supposed to be controlled. Social reform is seen as fine tuning the social system. We respond to incremental change with expressions like "but look how far we have come". Yet living, like schooling, is not programable. Being in the world is being in conflict. Being in the world is being within a social setting that is also a contested terrain of many voices, experiences, interpretations. Working through the conflict, struggling and negotiating meanings on the contested terrain, can also leave on unsettled within the social setting. Feelings of chaos also occur. This too is part of the human condition.

We feel and experience post-modernism, within a context (school/world) that uses modernist language and thinking. This is unsettling. Is modernism an imposition of rational, linear, technical processes to control living/schooling? Is post-modernism experiences and feelings of chaos, conflict and struggle, all of which brings uncertainty because modernism is the dominant ideology?

A sociocultural perspective can bring these experiences of school/world together. Situating schooling within the larger context of living in the world is not a new idea. A sociocultural perspective sees no separation between the world and school. A sociocultural perspective understands the historical and acknowledges the political and economic realities. Social issues are school issues, and vice versa. An unquiet pedagogy, a critical pedagogy, confronts the social-school-life-world and acknowledges the conflict and contested terrain as the human condition.

An unquiet/critical pedagogy is informed by and allows for the technical, practical and emancipatory forms of knowing within the learning process. An unquiet/critical pedagogy understands the notions of cultural capital, achievement ideology and social reproduction, as well as the social construction of knowledge (knowledge is created rather than consummed).

An unquiet/critical pedagogy acknowledges student/teacher voice in the learning process. This pedagogy fosters and helps create democratic schooling through confronting issues of social justice, the common good, and the creation of community.

Technology is a part of this world of the educational community. Therefore....

SOME REFERENCES:

Works by the following authors have helped to inform my thinking:

Russell L. Dobson/Judith Dobson/ Michael Apple/Henry Giroux/Paulo Freire/Peter McLaren/Jay MacLeod/Ira Shor/Jurgen Habermas/Antonia Darder/Lois Stalvey/Mike Rose/Eleanor Kutz & Hephzibah Roskelly/ Herbert Kliebard/Robert Young/Maxine Greene/

Where do you stop?

Conversation and support from the following has been significant and important:

Chute/Martin/Robinson/Nichols/Yeaman/Januszewski/Muffoletto/ DeVaney/Lukowsky/McIssac/Taylor/Johnsen/Fosnot/Combs/I know I left people out. I'm sorry.

Dallas, 1982 was the beginning; New Orleans, 1983 was the first; New Orleans, 1993 was the tenth; here is to ten more....JRK

Schools and Technology in a Democratic Society:
Equity and social justice

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(This working paper was written for the 1993 meeting of the Association for Educational Communications, Research And Theory Division forum on ethics and technology. Any comments and discussion is welcomed.)

Questions needs to addressed concerning the role of public education in a democracy. As individuals, and as a profession, involved in the research, development, production, and dissemination of educational experiences for children and adults, we need to consider what we have created and will create in light of social justice and democratic principals.

Our history is full of attempts to design and produce effective learning environments (In using the term "our" I am referring to those of us working in educational technology. I also realize its not our history but "a" history that has evolved out of conflicts and contridictions representing various interest. There are many histories, many voices.). We have consumed various learning theories and have produced various formats for the delivery of curriculum materials. Our purpose has been to increase the effectiveness of teaching materials and the efficiency of the learning process.

Our field is grounded in logical positivism, capitalism, and a 19th and 20th century notion of progress and classical realism. Technology, both as machine and as system, was and is linked with modernism and progress. Reality, especially social reality, and the stories told about it by experts, is understood to exist outside the individual and has for the most part gone unquestioned and unrecognized by researchers in our field. Beneath all of this lies the ideology of the machine and the expert (Muffoletto, in press).

Our field has strived to create through various presentational formats "a" reconstructed reality. Most of the debate in these attempts has centered on the veracity of the experience; does it feel real, does it reflect reality, is it efficient, and is it effective in its delivery. There has been little debate on the consequences of those strivings for a reality on the lives of real people and their culture. With the recent developments in virtual reality and multi-media hardware and software we must begin and continue our attempts to address the psychological, social and political implications and effects of what "we" do as perceived experts, as educational technologists. No longer can we afford to claim the neutrality of a modernist tradition or the non-historical consciousness which accompanies a positivist discourse towards reality and experience. As educators, researchers, and developers of learning experiences we must find avenues and entry points for debates and practices that argue and provide for spaces that support and maintain democracy and social justice. The first step I believe is to recognize ourselves for what we are; a social, historical, and epistemological construction. The second step is to define what we mean by democracy and social justice. The third is to position our definitions in practice.

Technology as a medium for discourse

Technology is more than a tool, it is a medium which effects how we think and interact with others and machines (Rheingold, 1991). It is a form which not only controls and limits discourse but determines the nature of the content as well (Postman, 1992). Technology is more than access to information and learning experiences. Technology determines the nature of that information as well as our understanding of it. As a medium of experience (discourse), technology effects our consciousness, our visions, and our expectations. The "wetware" of a modernist technology constructs the individual as a subject (Berger and Luckmann, 1966; Muffoletto, 1991). The technological medium is more than a mind manager and a reality simulator, it is a consciousness generator --an ideological horizon line.

Information

If technology is to provide us with access to information, there are a number of issues that must be considered and addressed. Simply providing access to information is not enough in a social context were historically access has been limited to the wealth, gender, and race of the individual or community. Access to information must also include equity in access to ways of "thinking" about information. If information is to be used to empower people within the democratic tradition, then educational experiences must provide a means for equal access to ways of thinking as well as valuing different ways of thinking.

To have information and not know what to do with it, is as serious problem as not having information at all (Of course this begs the question about the nature of information, epistemology, legitimization). Individuals who historically have been positioned on the margins of power and knowledge because of their culture, their economic class, their gender, their race, or their religion, may have been given equal access to information (even in limited ways), but not ways of knowing (thinking). For example, the cultural ways of making sense in the United States has been limited to primarily one cultural and economic framework (white, middle-class, male, and European). How one thinks about the world and one's self in it determines the rationale for understanding why things are the way they are (common sense), and not why reality is thought about in that manner.

How one thinks about the world as well as self, is how one has been told to act and think in relationship to self and others. Having information, but not divergent ways of thinking, maintains the individual and the community in a powerless relationship to those who do. Having access to information may create a false consciousness resulting in less real power than before.

Simulations as experience

Virtual reality, as a technology of experience, poses a number of questions. First and most basic, we must consider what the relationship is between a "virtual" reality and something we call reality. Is it good enough to be concerned with only the veracity of the experience and its correspondence to what is believed to be out there? (The physical and social sciences can be separated here, but questions concerning how we know reality and truth are essential to both paradigms.) In doing so we must offer up for analysis the manner in which we came to think about what is out there. We tend to forget that our understanding of what we think is out there is a result of the tools we use to explore it, the language we use to construct it, and the context or system (Goodman, 1978) used to understand it. Change the tool, the language, or the system, and reality differs. As individuals concerned with the creation of simulations, other worlds, we can not forget that we exist within a social reality, a virtual realty of sorts. We must also recognize that through discourse management, constructed reality has become reified and objectified.

Second, if virtual reality is understood in terms of simulations, looks, feels, and sounds alike, can not that simulation be understood as a discourse. As a discourse virtual reality must be analyzed as any other discourse? Borrowing from Cherryholmes (1988) we would need to question virtual reality by asking: Who is controlling the discourse (reality)?; Who is allowed to speak and listen?; What is being said?; Who benefits from what is being said?; and What is not being spoken about?

Any simulation or virtual reality must be considered from two different perspectives. On one side we must consider who is constructing the world to be experienced by users (students, teachers, workers, infonauts) Notions concerning hypertext environments, interactive video, and virtual reality include authors and readers, guides and travelers, navigators and explorers. No technological environment, as a system, is authorless. Every author, every programming production team, every navigator, holds a world view, an ideological perspective, a consciousness about self and others. On the other side, what are the social, psychological, and political effects of a constructed world on the readers of the virtual text.

Social Learning

How "we" come to be as subjects, as social beings, is a result of experiencing constructed texts (texts is used here in a post-modernist manner) and meanings (Belsey, 1980). All texts are hegemonic and are part of a larger discourse encoded with meanings, values, and ideological perspectives on others and self. How and what we learn about a social world is the result of experiences with various discourses about that world. In doing so, we either reproduce dominate meanings and ways of knowing or offer oppositional and alternative discourses (Hall, Hobson & Willis,1980). In either case, individuals as members of interpretive communities (Fish,1980) understand a reality to be as it is, to be real and truthful, because of their experiences with various formative and informative discourses (Ellsworth& Whatley, 1990). Questions referring to equity and social justice emerge out of a discourse on social learning, power and control, benefit, and history.

School Reform and Technology: Towards Social Inquiry and Justice

Curriculum materials, delivery systems, and learning environments may be understood as social texts, representational in nature, always overtly referring to something else, while covertly referring to themselves as a formative medium. The form and content of learning environments not only speak to methods and content, but also refers to ways of thinking and knowing. Thinking about all learning environments, methodologies, and contents as representational, as ideological representations, adds another dimension to our thinking about schooling, technology, and change.

Change always refers to difference. In education as well as business change is considered as a reply to some identified problem. How these problems are identified is as important to understand as what the problem is reported as being. Needs assessments, goal development, and vision statements refer to a history, the present, and to a future. Futures are normally related to notions of progress.

What the problem is, is determined by who (who being not an individual but a community) is asking. If problems and solutions are defined in terms of efficiency, outcomes, and management, the problems and solutions will be of one nature. If problems are contextualized in a discourse of democracy and social justice, efficiency, outcomes, and management may be part of the solution but to "what and how" they refer to will be different. As education in the United States considers why and how it must change, technology as a medium which effects knowing, institutional and individual relationships, as well as a sense of self and others, must be better understood within a discourse of democratic ideals. The problem needs to be redefined. (Again, the language has to be problemized whenwe consider that there is not one education, but many.)

Critical Theory and Educational Technology

Critical theory offers an entry point for unpacking the values, assumptions, and practices of educational technology. From a post-modernist perspective critical theory claims no absolute authorship. It declares its own subjectivity and ideological construction. As a theory working within a post-modernist tradition, those who practice critical theory are concerned with questions of power, control, and epistemology as social constructions with benefits to some and not to others.

A critical theory of educational technology would be concerned with issues of consciousness and epistemology, power and control, institutional and individual relationships (Feenberg, 1991). Questions concerning equity and social justice, and the construction of individuals as subjects within an ideological discourse would be critical to the unpacking and redefinition of the theories and practices of educational technology. A major impact of critical theory on the field of educational technology would be to recognize itself as a social construction with a history of conflicts, struggles, and contradictions. In understanding the social and historical nature of the field, the values and assumptions which are expressed through various discourses would be open for analysis.

Conclusion

Schooling in reflecting a democratic society, requires a society to be democratic, non-racist, non-sexist, and not class based. In positioning education as a major socializing institutions, with a major role in forming the worldviews and subjectivities of its participants, the products and processes of educational technology do play a major role in how communities of individuals think about others and self. A critical theory position, breaking from the common sense reified world offered by modernist and positivist alike, would need to address issues concerning the function of schooling and a technology of instruction in a democratic society.

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Critical Theory, Educational Technology, and Ethics: Helping Teachers Respond Meaningfully to Technology.

Association for Educational Communications and Technology
Randall Nichols, University of Cincinnati
Presented at AECT, 1/93

"...critical theory turns its face resolutely away from all forms of dogmatic authoritarianism, asserting the necessity of a transformation of conscious control over system imperatives through democratic communication processes" (Young, 1990, p. 55). Critical theorists aim to move people to freedom via a changed consciousness brought on by democratic communication. Our transformed consciousness is to include not only the technical and practical forms of knowledge that now dominate our lives but the emancipatory forms of knowledge which express not only what can be done but which should be done, which put truthfulness and sincerity on a par with being right, which are subjective as well as objective (Habermas, 1984, 1987; Ewert, 1991). Put similarly, instrumental reason is to be re-unified with political-ethical reason (Young, 1990, p. 17).

A primary method of a critical theory of educational technology must be to expose the ways ideologies are developed and perpetuated via language forms. For present purposes, ideologies are perpetuated via "languages" which include technologies.

Ideology can be described as "The values and interests of ruling classes and elites [that] are installed in the very design of rational procedures and machines even before these are assigned a goal" (Feenberg, 1991, p. 14) as well as the values and interests in the goals of technology. A television expresses the political-ethical interests of the Sony Corp. to have power over consumers, especially via money and technology, and especially in such a way as to keep the technical, practical, and political-ethical knowledge held by the corporation away from consumers and others.

Language can be taken primarily to be spoken or written Spanish or Russian, for instance, but it also is a more technical form such as computer programming languages, it is representational visual images such as paintings or holograms, and it is even symbols such as computers, cars, and beer bottles and the ways they speak to humans.

Technology can be the belief in and application of rational/systematic thinking. It is manifested in a belief in technology, in products such as gas chambers, and in processes such as science.

Educational technology can be any technology and a belief in any technology used to change humans, though change usually is prescribed and occurs within formal bounds of schooling.

More than exposing ideologies in languages, the method of critical theory (and so of a critical theory of educational technology) includes "immanent critique, which proceeds through forcing existing views to their systematic conclusions, bringing them face to face with their incompleteness and contradictions, and, ultimately, with the social conditions of their existence" (Young, p. 18).

For example, educational technology perpetuates students' lack of critical thinking because it promotess mostly technical interests and rational-instrumental thinking. It fosters the dominance of financiers, politicians, militarists and professional educators over students. Further then, educational technology limits democracy and sincere communication because people are less able to think critically about politics (Koetting, 1983; Nichols, 1990).

A technical and practical ideology rather than a democratic-communicative ideology appears predominant in all of education. That is, students and teachers are not responsible for knowledge and education but for fulfilling the desires of others, especially the desires to have power and make money. As a result of this dominance, kept from authentic motivation, students don't want to know much and can't know much, teachers don't learn or teach much, and people and society loose hope and act non-communicatively, on the whole. Schools are filled with demoralized people who don't know or often care that they are not communicative. 30-40 per cent of American students drop out of school.

If we are serious about the "education" in "educational technologist," we must critically study this dominance. Such study is ethical/moral because of its potential to encourage greater fulfillment of human communication. Freedom of communication is moral. We will make human and ecological progress to the extent that we re-acquaint technical reason with moral reason.

Carr and Kemmis (1986) offer examples of ways to critically study educational technology, as do critical pedagogists such as Weiler and Mitchell (1992), as do Randy Koetting, Rhonda Robinson, and the other presenters at this symposium.

Problems with a critical theory of educational technology include:
1. Is social-material progress as meaningful as critical theorists indicate/hope?
2. Will a higher rationality will be more helpful to human dignity, if a lower one has gotten us into the scrapes we're in now?
3. Can critical theorists reach their intended audience (proletariate/teachers/students) with the technical language they employ (Young, 1990)

Maybe because of these problems, critical theory, at least in its academic forms, has not reached American students or school teachers in any widespread way. Virtually no students have heard of "critical theory." Beyond having heard the phrase "critical theory," and more importantly, most students are not deeply sensible that their communicative (so political-ethical) freedoms are submerged and restricted. They can't be in today's predominant modes of education.

The most crucial question for educational technologists remains: How can we get students to participate in all aspects of educational technology when the likes of freedom, justice, equality, and physical existence are hardly open to conversation?

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Symposium: Continued Dialog on Critical Theory, Cultural Analysis & Ethics

Where in the World is Jacques Derrida?

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The authority of the text has gone, probably stolen. The literature police called in the philosophy detectives. Together, they uncovered proof that Jacques Derrida had his eye on it for a while. Also, around the same time it was noticed missing, he began traveling widely, popping up at many seminars and lectures in Europe and North America.

Interrogations of possible witnesses show that the meaning of meaning is shifting. As soon as a lead is established, contradictory information drives the investigation onto another track. Anyway, whether he did it or not, the plan for the theft seems to appear in Derrida's *Structure, Sign and Play in the Discourse of the Human Sciences* which identifies paradoxes in structuralist reading. That conference paper reveals the pretense of contextual stability and introduces a new term: deconstruction. Not long after, Derrida provided another clue by Xing-out words as a visual sign that signs themselves are unstable and changed as soon as they are understood.

Other suspects, Roland Barthes and Michel Foucault, died under unusual circumstances and left behind suspicious documents. Between them, Derrida, Barthes and Foucault have over 60 English titles listed in *Books in Print* but there seems no indication of conspiracy. These three French writers considerably influence the contemporary teaching of English, language, literature, social studies, and similar subjects at the secondary and college levels. As a consequence, students may be becoming less intellectually docile as classroom learners and less malleable, after graduation, when exposed to new employee training.

Would-be followers surface from time to time, apparently expecting a rendezvous, but Derrida disavows them–just as he did Socrates who was picked up at the scene of the crime. Clearly the wrong guy but surely up to no good, Socrates was arrested on the related charge of teaching effectively–which shows the danger of educational communications and technology.

Derrida challenges the assumption that spoken language, the most immediate of communication media, can be accepted as the closest representation of thought. It is a non-neutral medium shaped by ideology and bias. No way of communicating, whether in speech or writing or painting, for example, is more or less direct or unequivocally better. Language has become endlessly self referential and this belief is unlikely to be reversed even if the authority of the text is restored. The tradition of searching for an author's intended meaning in a text is reduced to a mere preconception.

Other than a bungled arrest and deportation from Prague (it was obvious the drugs had been planted) Derrida has a clean record. On the face of it, he is a law abiding citizen and even writes with a word processor (Macintosh). Nevertheless, he once expressed misgivings about reading aloud an oath to respect the rules of a library. Politically, he has been active with the communal International College of Philosophy, administered by Jean-François Lyotard. This project developed out of a collective appeal to release philosophy from the prison of higher education. It may only be coincidence that the Groupe de Recherches sur l'Enseignment Philosophique is known by its initials: GREPH. The concealed use of the Unix command "grep" is possibly a ruse to cover a deep-rooted interest in telecommunications. In the United States, for example, J. David Bolter, Michael Joyce and George P. Landow have gained attention for applying Derrida's ideas to designing and understanding the design of computerized texts and education.

There are social consequences here that threaten to disrupt power and established authority. How can minds converge if it is a fallacy to think of thought as language because language itself is undecidable? However, at this point, the evidence against Derrida, the likely ringleader, still remains only hearsay and it is now becoming increasingly uncertain exactly what has disappeared.

Title:

Curiosity as a Personality Variable Influencing Learning in an Interactive Environment

Authors:

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ABSTRACT

This study investigated the effect of curiosity in first and second grade children as an individual difference variable in learning in a computer-based interactive learner control environment. The instruction was an art education lesson and contained both facts and concepts. Learner control varies by the degree of instructional control which a student has over his/her own learning. In a "complete learner controlled lesson," the learner makes his/her own decisions about issues such as content selection, sequencing, pace, and remediation. In a "learner controlled with advisement lesson," the learner makes the same type of decisions but is provided advisement about the decisions and other learner control options.

This study used two learner control treatments: 1) learner control without advisement (No Advisement) and 2) learner control with advisement (Advisement). High curious subjects, who generally prefer a higher degree of unfamiliarity and uncertainty, were predicted to perform better in a learner control environment than low curious children; both treatments represented a learner control environment. All children regardless of curiosity level were expected to perform better in the Advisement condition than in the No Advisement condition.

As predicted, there was a significant difference in achievement scores in favor of the high curious children in both learner control conditions. The results of this study suggested that differences in curiosity influenced performance within either type of learner control CBIV lesson. The differences were independent of grade level or gender. Research has shown curiosity to be independent of IQ.

Although there were no significant differences overall for treatment, there was a significant interaction between grade level and treatment. Grade one subjects performed significantly better in the Advisement condition than in the No Advisement condition while grade two subjects performed significantly better in the No Advisement treatment. Examination of in-treatment data indicated that the grade one subjects heeded advisement more than the second grade subjects which might explain why that group performed better in the No Advisement treatment. A possible explanation for the unexpectedly high scores of second graders in the No Advisement treatment may have been due to the predominance of high curious subjects in that treatment group; high curious subjects would be expected to perform better in a situation of greater uncertainty than low curious subjects.

Implications of the findings for instructional designers and educators in planning instruction are discussed.

INTRODUCTION

A RECIPE FOR LEARNING

> *Take a student, place him in a situation*
> *of moderate uncertainty about some topic*
> *and get out of his way while he gets*
> *excited and attentive and directs his*
> *exploration to the source of his uncertainty.*
> *Moreover, research has demonstrated*
> *that he will enjoy his exploration and*
> *the accumulation of knowledge.*
>
> Day, 1982, "Curiosity and the Interested
> Explorer" p. 19

Research on individual differences in cognitive development has largely centered on intellectual aptitudes somewhat diminishing the importance of other aspects of intellectual development, such as intellectual styles (Henderson & Gold, 1983). These styles include cognitive styles, creativity, and the subject of this study, curiosity. Stimulating curiosity in the academic environment is a challenge for educators. Curiosity motivates scholarship. A curious student will want to explore and learn. Curiosity is motivation which is intrinsic as opposed to motivation which comes as a result of external incentives, such as rewards or threats of test taking.

However, not everyone is equally curious. Day (1982) discusses the tendency for some students to become curious more readily. They enjoy opportunities to explore at will while others are less tolerant of unfamiliarity and uncertainty which are almost always present in a situation in which curiosity is aroused.

Not only do people differ in curiosity as a personality trait but environment is thought to play a part as well in the development of curiosity in students. Some students, according to Day (1982), may have had their disposition to be curious dampened at an early age by, for example, being punished for asking too many questions or exhibiting curiosity in numerous ways. It is up to the teacher (or, in the case of technology, the teacher 'function') to give these pupils special training "so that they may become curious once again" (p. 21). Although future studies should address whether trait curiosity can actually be enhanced, the focus of the present study was to explore the effect existing individual differences in curiosity level have on learning in situations which differ in amounts of learner control. Since learner control situations invoive different amounts of uncertainty, awareness of individual differences in curiosity potential is essential to the planning and design of instruction.

Planning for how to deal with curiosity is not only a challenge for educators but also for instructional designers and developers of the many interactive learning technologies that are emerging. The present study utilized computer-based interactive video (CBIV). CBIV involves the interfacing of computer technology and video in such a way as to allow active user participation and the opportunity to modify pace, content sequencing, remediation choices, etc., as a result of a viewer's response. The amount of interactivity in a CBIV lesson, however, is based to a large extent on the degree of learner control which is afforded by the lesson.

A number of studies exist on issues related to learner control (e.g., Balson, Manning, Eber & Brooks, 1985; Gay, 1986; Hannafin & Colamaio, 1987; Gay, Trumbell and Smith, 1988) although there are relatively few studies which explore this area with young learners. Prior research suggests that higher achievement scores are possible when there is a component of advisement included in a learner control lesson (Tennyson, 1980; Johansen & Tennyson, 1983; Tennyson, 1984; etc.). This finding was found even for children (Arnone & Grabowski, 1992). There is also substantial research in the area of curiosity and motivation (e.g., Berlyne, 1954; Berlyne, 1960; Maw & Maw 1964; Maw & Maw, 1965; Maw & Maw, 1966; Day, 1968; Wilson, Stuckey & Langevin, 1972; Vidler & Rawan, 1975). These areas of research exist independently of each other, and as such, little is understood about the effect of personality variables such as trait curiosity on learning in a learner control environment or about the interaction of such variables within different learner control situations. Questions remain regarding the effect on performance of one's predisposition to be curious. Will the initially more curious child be more capable of accepting greater degrees of control over their learning because their optimal arousal level is higher (and therefore their comfort zone for uncertainty)? The purpose of this study was to investigate the effect of curiosity as a personality variable on learning in an interactive learner controlled environment.

CURIOSITY

The Construct

Curiosity is often associated with exploratory behavior. The purpose of exploratory behavior is to keep one's level of stimulation at what Berlyne (1960) in his neurophysiological model of arousal calls the "tonus level." (The tonus level is a moderate pleasurable level of stimulation at which an individual functions most effectively.) Berlyne identified two forms of exploratory behavior, "*diversive exploration*" and "*specific exploration*." Diversive exploration occurs as a person seeks new experiences or relief from boredom whereas specific exploration is encountered in situations in which there is conceptual conflict arising out of uncertainty or novelty. Specific exploration is described within the context of epistemic curiosity, that is, "the brand of arousal that motivates the quest for knowledge and is relieved when knowledge is procured" (Berlyne, 1960, p. 274). Epistemic curiosity, then, motivates exploration which resolves the conceptual conflict and returns the individual to a pleasurable tonus level. It is important to note that small increases in stimulation are considered pleasurable because of the resultant return to the tonus level when the conflict is resolved. However, large increases are not considered pleasurable and will result in the individual making attempts to return to the tonus level. One way the individual may attempt to return to the tonus level might be to reduce the stimulation by actually withdrawing from it, for example.

Berlyne's theory of curiosity involves a construct known as "*collative variability*." Collative variability relates to how complex a stimulus is and how easy or difficult it is for the individual to collate, that is, to compare the stimuli to that which the individual is familiar. Collative properties have the potential to increase arousal level and induce curiosity. Day and Berlyne (1971) note, however, that individuals differ in their tolerance and preference for arousal potential. While some individuals may react with interest and exploration to a given amount of arousal potential, another individual may become inefficient and withdraw from the same stimulus.

Day (1982) describes this arousal theory as a curvilinear relationship between efficiency (in terms of learning) and arousal. The optimal level of arousal is one in which the individual enters a Zone Of Curiosity and is willing to approach or explore his/her environment in order to resolve the cognitive conflict that was initiated by the stimuli. When the conflict is resolved generally by seeking answers, etc., the individual returns to a resting place which is the pleasurable tonus level. However, in the event that there is too much stimuli or it is too complex, unfamiliar, or the degree of uncertainty too high, the individual will enter a Zone of Anxiety in which he/she becomes disinterested and inefficient. Performance, it would follow, is negatively affected. Day (1982) writes that "collative variability is to be found in characteristics of stimuli usually labeled with such adjectives as complex, novel, incongruent, difficult, and obscure" (p. 21).

Is this construct separate from intelligence? Day (1968) found no significant correlations between scores on his Test of Specific Curiosity and total intelligence scores. Langevin (1971) found curiosity measures which he tested to be distinct from intelligence on the whole. The arousal model put forth by Day and Berlyne (1971) suggests that intelligence alone is inadequate to account for classroom achievement. They note that the next "most potent factor is probably motivation" (p. 295). Curiosity is motivation which is intrinsic.

Defining curiosity for this study. Maw and Maw (1966) describe curiosity as an arousal state in which the individual desires to know more about one's self or environment. Since much of Maw and Maw's work built upon that of Berlyne, and because their operationalized definition of curiosity involved children, it was particularly useful to the present study. According to Maw and Maw (1964), "...curiosity is demonstrated by an elementary school child when he:

1. reacts positively to new strange, incongruous, or mysterious elements in his environment by moving toward them, by exploring, or by manipulating them.
2. exhibits a need or a desire to know more about himself and/or his environment.
3. scans his surroundings seeking new experiences.
4. persists in examining and exploring stimuli in order to know more about them" (p. 31).

Cecil, Gray, Thornburg, and Ispa (1985) extend the definition of Maw and Maw and consider curiosity to be an arousal state that leads to and is a prerequisite for exploration, play, and creativity. Beswick and Tallmadge (1971) describe a cognitive process theory of curiosity in which curiosity is related to conceptual conflict. In this theory, "the trait of curiosity is defined as an individual's readiness or predisposition to seek, maintain, and resolve conceptual conflicts" (p. 456). In proposing a model of teaching and learning, another author defines curiosity as "the individual's desire to question or investigate" (Parker and Engel, 1984). Penney and McCann (1964) make a distinction between curiosity and reactive curiosity stating that a child may be curious but may not react to his or her curiosity. The definition is very similar to that of Maw and Maw.

Curiosity as trait and state. The literature suggests that curiosity is both a *state* and a *trait* variable (e.g., Day, 1982). As a state, curiosity is a motivational variable which varies depending on the situation in which curiosity is aroused and individual differences. As a trait, curiosity is a more stable variable indicating individual differences in one's potential to experience curiosity. A study by Naylor (1981), gave support for the theoretical distinction between state and trait curiosity. According to Naylor, people who are higher in trait curiosity should experience curiosity arousal across a wider range of situations and will also have the capacity to experience greater intensities of state curiosity. Berlyne's theory is concerned with curiosity as a state of arousal brought about by stimuli high in collative variability and uncertainty. The theory does not, however, overlook the importance of individual differences or what is generally termed trait curiosity. As mentioned earlier, both Day and Berlyne (1971) agree that individuals differ in tolerance and preference for arousal potential: "When confronted by a specific amount of arousal potential, some people will react with positive affect, interest, and exploration. Others may become overly tense and inefficient, and try to reject, avoid, or withdraw from the source of stimulation" (p. 304). This study investigates trait curiosity. The relation between state and trait curiosity should therefore be important to educators who must balance the amount of stimulation designed to arouse curiosity (the motivational state of curiosity) with an awareness of different individuals' tolerance for arousal potential (curiosity as a trait variable).

Specific and diversive curiosity. Curiosity has been described as both a state and a trait, arising out of both specific and diversive exploration. Berlyne's distinction between specific and diversive exploration was built upon by Day who developed tests of specific and diversive curiosity (Maw & Maw, 1977). Generally, people are pre-disposed to traits associated with being specifically or diversively curious. Referring back to Maw and Maw's (1964) definition of curiosity on page 10, parts 1, 2, and 4 of their definition refer to specific curiosity while part 3 refers to diversive curiosity.

This study investigated differences among children in trait curiosity. However, in as much as the two learner control treatments were designed with different amounts of uncertainty by virtue of advisement versus no advisement, these conditions can be thought of as affecting state curiosity which should affect performance as well. Some authors (e.g., Necka, 1989) discuss strategies designed to nurture trait curiosity through instances of increased state curiosity. Such strategies included brainstorming, role playing, and putting forth questions of the "I wonder if really...?" genre. This seems to indicate that perhaps curiosity as a trait (as opposed to a state) can be enhanced but no longitudinal studies of this sort could be found. A number of studies cited in a review by Maw and Maw (1977) show high and low trait curiosity prevailing under certain conditions in which state curiosity was either consistently stimulated or modelled or it was not. A few other studies discussed in Maw and Maw's review included strategies for raising curiosity by training pupils to ask questions.

The present study was limited to investigating the effect of trait curiosity on learning in a learner control environment.

LEARNER CONTROL

The Construct

Defining learner control for this study. "Learner control" as a general concept, and terms which are related to learner control, such as "advisement," should be defined.

This study uses Milheim and Azbell's (1988) definition of learner control as:

> ...the degree to which a learner can direct his or her own learning process...[The term] most often describes the instructional choices made during a particular lesson. By definition these choices can be made either by the instructional program (as originally defined by the designer) or by the learner during the presentation of materials (p. 3).

A lesson which is highly controlled by the programmer and whose path and possible choices are predetermined is generally called a "designer control" or "program control" lesson. A lesson which allows the learner to control options such as path through the lesson, choice to exit, choice to be remediated, pacing and so on is called a "learner control" lesson. One which affords opportunities for exploration and learner control but with advice ranging from information provided about the student's progress to suggestions for sequencing or other meaningful learning advice is often called "learner control with advisement."

Selected Research on Learner Control

A number of studies show that positive effects have been achieved with the use of interactive video (e.g., Dalton, 1986; Bosco & Wagner, 1988; Hannafin & Colamaio, 1988; Abrams, 1986). Of particular interest are the studies in which learner control was a factor. Some studies have shown positive effects related to increased learner control (e.g., Laurillard, 1984; Merrill, 1975). The addition of some form of **advisement** to a lesson involving learner control has been associated with positive results in increasing achievement (Tennyson, 1980; Tennyson, 1984; Tennyson, Christensen & Park, 1984). Gay (1986) advises that the appropriate level of learner control may be contingent on factors such as individual differences or prior conceptual understanding (Gay, 1986). No studies on learner control looked at adults or children's level of curiosity as a possible influencing variable on successful learning in various learner control situations. Most studies have used college students or adults as subjects. Hannafin (1984) notes that older learners may be better able to utilize the learner control options because of their refined cognitive abilities. Younger subjects (elementary or junior high school age) may not yet have the necessary skills to make the most of such a lesson. Arnone and Grabowski (1992) addressed ways of coping with this developmental challenge by including an advisement function with learner control.

The Bridge Study Between Learner Control and Curiosity

The Arnone and Grabowski study (1992) functioned as the bridge between some of the earlier research on learner control and this doctoral dissertation. For that reason, it is noted as the "bridge study" for the present work. It is one of the few studies which studied young subjects (grades 1 and 2) in research on learner control. The study found a significant difference in achievement between subjects in a total learner control lesson and subjects in a learner control with advisement lesson. That study did not, however, examine trait curiosity and its potential influencing effect on children's learning in different learner control situations. Will a more curious child be more comfortable about exploring in a learner control environment than the less curious child? Will the less curious child show higher performance on achievement in a learner control environment if advisement is provided? Since one aspect of curiosity is willingness to explore and tolerance for uncertainty in a situation, it was expected that there would be overall performance differences between high and low curious subjects in a learner control lesson and that there would be an interaction between curiosity level and the learner control treatment (advisement versus no advisement). The purpose of the present study was to extend the research by Arnone and Grabowski and to explore the effect of trait curiosity level of first and second graders on achievement in a learner control lesson.

PREDICTIONS

The research predictions must be prefaced with an interpretation of how the research in the two separate areas of curiosity and learner control in an interactive learning environment can be merged in a meaningful way. The following discussion proposes one way of thinking about this.

The Merger

It may help to conceptualize "learner control" as a continuum with no learner control on the extreme left and a high amount of learner control on the right. No learner control would mean no opportunities for exploration or choices. Such an environment would essentially shelter the learner from uncertainty since the programmer has basically mapped out a path for the learner.

On the opposite end of the continuum is a high degree of learner control which translates into many opportunities for exploration and choice. By its very nature, high learner control will present an environment which is less familiar, contains more collative variability by virtue of its many options, and has a much higher degree of uncertainty. The learner must encounter the lesson on his or her own, choose to go down a certain path with no guide, decide whether or not to avail himself/herself of the options or leave them be.

The mid-section of this continuum would be learner control with advisement or guidance. In this case, the learner would experience many and perhaps all the options available with a high degree of learner control but with one difference -- advisement. Exploration would take the form of more guided discovery. In essence, collative variability could be quite high but the uncertainty associated with it would be reduced through the guidance which helps in collation. If, as Day and Berlyne (1971) contend, collative variability is essential to arousing curiosity, but that too much collative variability can actually have the effect of depressing curiosity, then the midpoint on the continuum of learner control should be favorable towards increasing performance for all students, and particularly favorable for low curious students.

In the curvilinear relationship between arousal and efficiency of performance that Day (1982) describes, curiosity is a dynamic variable which can be induced or manipulated, while this study investigated curiosity as a stable trait variable. How then can that curve be interpreted in the present study? Using prior research on curiosity as support, it was predicted that the placement of an individual's curve on the arousal axis is partially dependent on how curious that individual is initially. For example, one would expect that, in the presence of stimuli with a high degree of uncertainty, a low curious student may enter the Zone of Anxiety, inefficiency, or disinterest sooner than the high curious child, resulting in a negative effect on one's score on a post treatment achievement test. The low curious child in any environment in which learner control was a factor was predicted to score lower on a post treatment achievement test simply because there is more uncertainty present than in a situation in which there was no learner control (e.g., program control). However, it was also predicted that the low curious child would score higher in a learner control lesson which offers advisement than in the same lesson without advisement.

The authors argue that Learner Control with Advisement encourages movement into the Zone of Curiosity with enough collative variability to be exciting and interesting but enough advisement strategies to reduce the potential for anxiety or inefficiency (in terms of cognitive processing) associated with uncertainty in a learner control environment. Figure 1 illustrates this interpretation. Higher achievement test scores following the lesson, therefore, were predicted. This effect was expected to be most pronounced with low curious students since their lower optimal level of arousal would be accommodated by the guidance afforded in the Learner Control with Advisement lesson, in essence, keeping them in the Zone of Curiosity longer.

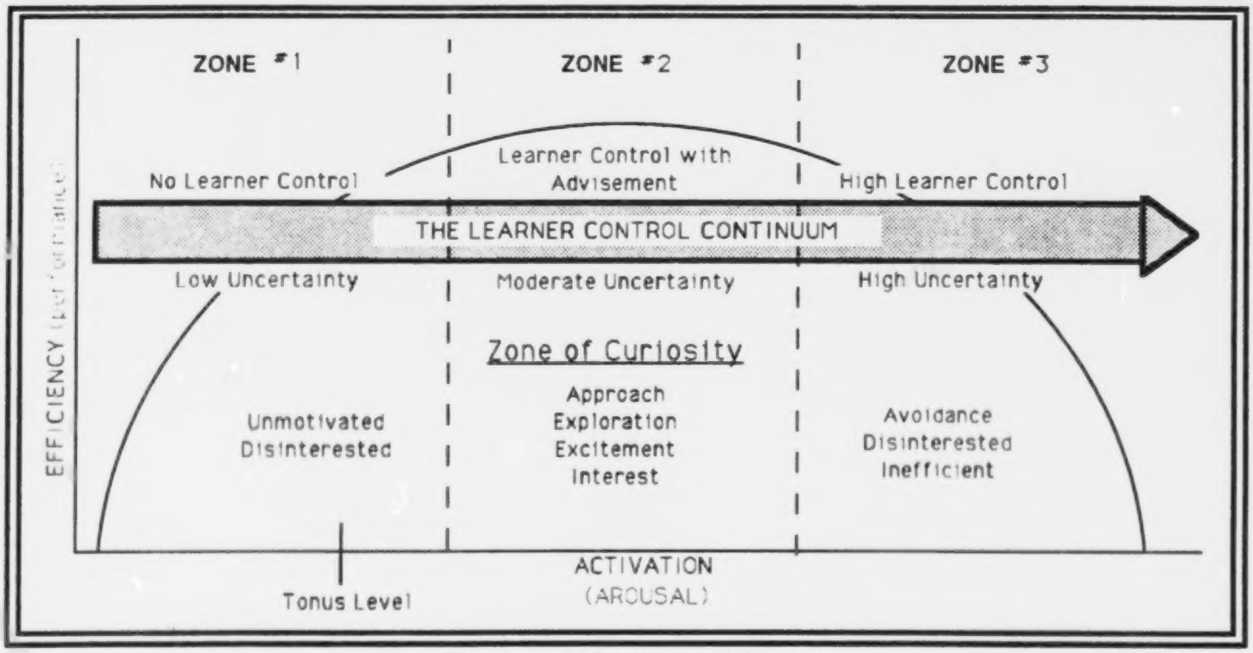
ZONE #1
ZONE #2
ZONE #3
No Learner Control
Learner Control with Advisement
High Learner Control
THE LEARNER CONTROL CONTINUUM
Low Uncertainty
Moderate Uncertainty
High Uncertainty
Zone of Curiosity
Unmotivated
Disinterested
Approach
Exploration
Excitement
Interest
Avoidance
Disinterested
Inefficient
EFFICIENCY (performance)
ACTIVATION
(AROUSAL)
Tonus Level

FIGURE 1 ☐ Learner Control and Curiosity
(Adapted from Day, 1982)

Predictions for performance can be related to figure 1 by noting that zone #1 was marked with disinterest and lack of motivation, zone #2 with approach and interest, and zone #3 with avoidance and disinterest. The zones reflect a curvilinear relationship with respect to performance. Figure 2 shows how differences in learner control which range from a low to high degree of uncertainty may be experienced differently by high and low trait curiosity subjects. The numbers within the cells refer to the zones described above and in Figure 1. Arnone and Grabowski (1992) found significant differences between learner control and learner control with advisement (high and moderate uncertainty) but found no significant differences between program control (low uncertainty) and the other treatments. Since this study built on the significant differences found in the previous study, it examined learner control without advisement and learner control with advisement (high and moderate levels of uncertainty), only.

		TRAIT CURIOSITY LEVEL	
	Degree of Uncertainty	Low	High
LEARNER CONTROL	High	3	2 or 3
	Moderate	2 or 3	2 or 1
	Low	2	1

FIGURE 2 ☐ **Predictions of Performance Based on Interaction Between Trait Curiosity and Learner Control**

Summary of Predictions

1) Learner control with advisement will be superior to learner control without advisement in promoting achievement in young learners.

2) High curious students will perform better than low curious students in a learner control environment regardless of treatment.

3) There will be an interaction effect between curiosity of students and lesson treatment.

METHOD

This study built on the previous work of Arnone and Grabowski (1992) and utilized the same lesson materials and the same post treatment achievement instrument. Same-age subjects within the same school district assured that a high degree of comparability could be achieved across the two studies. Since the important new dimension was trait curiosity, it was important to hold the other factors as constant as possible.

The study consisted of two parts: 1) a series of three pilot studies related to the testing and development of the curiosity instruments and 2) the main study involving the administration of the curiosity instrument, the intervention, and a post-treatment achievement test. Additionally, the main study involved interviewing a random sample of the subjects about their experience.

Only subjects with parental approval participated. The study was conducted in a school setting as opposed to the lab which afforded some veridicality with a real world learning milieu.

The three pilot studies were conducted in the months before the conduct of the main study to determine the appropriateness of four curiosity instruments for the sample. The first two pilot studies were administered to 18 children each in a different school district than the main study. The third pilot study took place within the same school district as the main study but at a different school and involved 60 children. In addition to providing the basis for selecting the curiosity instruments to be used in the main study, these pilots also contributed to fine-tuning administration procedures prior to the main study.

Subjects

A total of 84 first and second grade students from a suburban school district in Central New York participated in the main study. All 84 subjects were administered the preliminary curiosity measure, received the intervention, and took the achievement test. However, two subjects of the 84 were dropped, one because of computer malfunction (audio drop-out which lasted several minutes during the lesson treatment) and one because of administrator error (administrator did not set up computer for the graphic overlays). A total of 82 subjects remained.

The scores of the 82 subjects on the curiosity measure were collapsed into a categorical variable with two levels of curiosity. On a 20 item test, 36 subjects scored high ($\underline{M} = 7.19$), 11 subjects scored in the middle ($\underline{M} = 12.81$) and 35 subjects scored low ($\underline{M} = 6.26$). As planned, the middle scorers were dropped from the analysis leaving 71 subjects. The difference between the extreme scorers was significant at $\underline{p} < .0001$.

There were 36 high curious subjects and 35 low curious subjects. There were 31 males and 40 females. Thirty-nine subjects were first graders while 32 subjects were second graders. Sixteen first grade subjects were high curious while 23 first grade subjects were low curious. Twenty second grade subjects were high curious while 12 second grade subjects were low curious. Among first grade subjects, 25 were female and 14 were male; among second grade subjects, 15 were female and 17 were male. First graders ranged in age from 6 years 1 month to 7 years 3 months. Second graders ranged in age from 7 years 3 months to 8 years 6 months.

Materials

Materials as input to the study consisted of the curiosity assessment instruments, the lesson, and the two learner control treatments. Materials as output consisted of the post treatment achievement test, lesson log, and interview protocol. In this section, the lesson and the two learner control treatments are discussed. The other materials are discussed under "Instrumentation."

Lesson Description

The lesson content was the same as that used in the bridge study. A subject matter expert in art education provided the content for the treatments. The lesson was designed as a visit to an art museum. The subject matter expert had previously served as Curator of Education for the museum and it was possible to acquire many visuals for the treatments.

The lesson itself included a general introduction and three segments on ceramics, sculptures, and paintings. The content involved both facts and concepts and the lesson provided opportunities for practice, feedback, and remediation.

The lessons were designed for subjects with limited reading experience and contained no text. A narrator was used where text would have been necessary. The use of a touch screen in place of a keyboard further simplified the young learners' task of responding.

An interactive video lesson was developed to be delivered on a Sony Laservision videodisc player interfaced with a MS-DOS compatible computer, a touch-sensitive screen, and headsets. The lesson was programmed using ICON Author. A combination of motion video, slides, and computer graphics was used in the presentation.

CBIV Instructional Treatments

The treatments were labelled 1) Learner control without advisement (No Advisement) and 2) Learner control with advisement (Advisement). Both treatments contained the same essential content and both provided opportunities for practice, remediation, and feedback. Two instructional designers provided judgments on the appropriateness of the treatments in reflecting the constructs of learner control with advisement and learner control without advisement. The dissertation study did involve one change in the treatments. Rather than receiving two opportunities to respond to practice items, the lessons were re-programmed so that subjects were provided the opportunity for remediation or advisement after one incorrect response. The change was made in an attempt to strengthen the advisement treatment.

The average time spent in the learner control with advisement lesson was 13.2 minutes while the average time spent in the learner control without advisement lesson was 15.4 minutes. This did not include the time subjects spent in a pre-lesson warm-up which averaged 3.26 minutes or time spent in taking the post-treatment achievement test.

Learner control without advisement. In the learner control without advisement group, subjects were given the opportunity to sequence the material in any way they chose. Whether to review segments where practice items had been missed was also a decision left to these subjects. Students had the opportunity to omit entire sections or sub-sections, or opt out of the lesson altogether, if they so desired. Students controlled their own pace through the lesson. Additionally, subjects could freeze images on the screen. This was called a "Stop and Look" routine since whenever a particular icon was present, the subject could freeze the image on the screen to explore it more closely. Subjects were familiar with the icon since they were exposed to the icon and its meaning in the pre-lesson practice session.

Learner control with advisement. Subjects in the learner control with advisement group received the same opportunities to explore the lesson as the Learner Control Without Advisement group. However, certain "advisement" strategies were also employed in this group which provided some guidance when poor decisions were made and also encouraged guided discovery. For example, if a student decided to skip out of a section, he/she received this advisement: "Are you sure you want to end the lesson? This next section is very interesting. You might really enjoy it" or "Aren't you going to wonder about what you'll be missing?" Care was taken not to instill fear (related to the expectation of being tested) as a motivation to continue the lesson since such motivation is considered extrinsic and not compatible with the construct of curiosity under study.

While subjects in the learner control without advisement group could take advantage of the "Stop and Look" routine whenever they saw the associated icon appear on the screen, subjects in the learner control with advisement group were advised by the narrator to take advantage of the "Stop and Look" routine to explore the images more closely. The final type of advisement was in the form of a "Stop and Think" routine which generally was preceded by a question to arouse curiosity. For example, after presenting some interesting information about a painting that generally intrigued young children, this question was posed: "Do you wonder how you can tell this from looking at the painting? 'Stop and Think' about it! Then, touch the screen when you are ready to find out." All audio and visuals froze at that point and resumed when the subject touched the screen to proceed. The subject was in control of how long to "Stop and Think;" if the subject wanted to spend no time in this mode, all he/she had to do was to immediately touch the screen as soon as the narrator finished speaking. Other than the advisement, the instructional content remained the same as the other treatment.

Instrumentation

Curiosity Instruments

The two measures which were selected for use in the main study were:

--Maw and Maw's ***Which To Discuss Test*** (Maw & Maw, 1964) with a practice session and administration directions tailored to primary grades

--Arnone and Sciretta's ***Specific Curiosity Scale for Primary Grades*** *(SCSPG)* (Arnone & Sciretta, 1991)

The *Which To Discuss Test* does not require reading ability and is a test of specific curiosity which was appropriate for the study. It is comprised of 20 pairs of geometric symbols and figures. One symbol is more familiar and /or balanced than the other in each of the pairs. Preference for the unbalanced or the unfamiliar, according to Maw and Maw (1964) taps into the part of the definition of curiosity in which "a child manifests curiosity to the extent that he 'reacts positively to new, strange, incongruous, or mysterious elements in his environment by moving towards them, by exploring them, or by manipulating them.'" (p. 112). Using the Mann-Whitney U test, this measure showed significant differences between the means of the high and low curious fifth grade children supporting the hypothesis that high curious children select the unbalanced/unfamiliar more often than low curious children. Its reliability is high at .91 computed by the split-half method; Silverstein et al (1981) used Cronbach's alpha to measure the test's internal consistency and calculated it to be .90.

The *Which to Discuss Test* provided the basis of assignment into curiosity groups as it correlated positively with teacher judgment of curiosity in the pilot study, and because Maw and Maw had previously validated the instrument on elementary school children. It also had higher reliability than the newly developed *SCSPG*. In the main study, the *Which To Discuss Test* received the same reliability coefficient using Cronbach's alpha as it did in the pilot studies ($\underline{n} = 84$, $\underline{r} = .90$). The reliability coefficient of the *SCSPG* using Cronbach's alpha was $\underline{r} = .58$ in the main study. The *Which To Discuss Test* showed a significant positive correlation with the *SCSPG* ($\underline{r} = .29$, $\underline{p} = .008$). Since the *SCSPG* contained items which encompassed all the aspects of specific curiosity and the *Which To Discuss Test* focused on only one aspect of specific curiosity, another correlation was computed. This analysis involved correlating only those items of the *SCSPG* which represented the aspect of curiosity measured in the *Which To Discuss Test* (i.e., preference for the unfamiliar) with the total score of the *Which To Discuss Test*. This time the correlation was much higher ($\underline{r} = .48$, $\underline{p} = .0001$).

Another reason for choosing Maw and Maw's test for the purposes of grouping is that it focused on the aspect of curiosity (preference for the unfamiliar/willingness to explore) most related to the experimental treatments. The primary purpose of administering the *SCSPG* in the main study was to add further construct validity to Maw and Maw's scale and to provide one more opportunity for refinement and analysis of the *SCSPG*.

Scoring for curiosity instruments. In the *Which To Discuss Test*, the child received 1 point for each item which showed a preference for the unfamiliar and 0 points for items which did not indicate this. The total score was the sum of points received. The *Specific Curiosity Scale for Primary Grades* was scored in the same way, that is, subjects received a 1 for responses which indicated specific trait curiosity and a 0 for responses which did not. The minimum total score a subject could receive was 0 and the maximum total score possible was 20 for each of the two measures. The actual scores ranged from a low of 0 to a high of 20 for the *Which To Discuss Test* and a low of 6 and a high of 19 on the *SCSPG*.

Achievement Instrument

The present study used the same achievement test which was used in the bridge study although it was revised for ease of administration. The subject matter expert reviewed the original achievement test for content validity and determined that it adequately represented the content presented in the lesson. A content table of specifications was used to derive the items for the achievement instrument and to insure that the items were weighted in accordance with their importance in the lesson itself.

Part of the challenge of designing materials to measure the effectiveness of the treatments had to do with the type of content to be presented. "Pat" answers are inappropriate in an area such as art education and museums. In measuring achievement, it was necessary to devise an instrument which gave the child the opportunity to be more expressive while demonstrating that he/she had indeed acquired the new information. Although the bridge study also included an instrument to measure whether curiosity had been aroused more by one treatment than another, the present study looked only at achievement.

The achievement test, then, consisted of 8 items which measured whether learning of the content had occurred. A number of points could be accrued for each item. To control for order effect and fatigue, the computer was programmed to randomly generate the order of test items for each subject. Because of the open-ended nature of the questions, it was found in the bridge study to be necessary to distinguish between responses which were specific to the lesson (lesson-related) and those which were not (lesson-unrelated). This study also used the same method in differentiating responses.

Scoring for achievement instrument. In the achievement measure, the subject was presented video still images of aspects of the museum encountered in the lesson such as paintings, sculptures, and ceramics. For each item, the administrator requested the subject to tell her everything the subject knew about the picture. Responses were recorded on a paper and pencil instrument and scored later. After responding, the subject touched the screen to proceed to the next image. The instrument was devised to take somewhat qualitative data and give it points based on 1) recall of facts and concepts introduced in the treatment and 2) number of appropriate responses. The minimum possible score was 0 if the child gave no appropriate responses. The maximum possible score was derived from a content analysis of the lesson. There were 102 possible acceptable responses which were considered lesson-related. The reason for the high number of potential responses was due to the open-ended nature of the instrument. The actual scores ranged from a low of 3 to a high of 40.

Interview Protocol

Twenty-five subjects were randomly selected for brief interviews following the achievement test to garner qualitative information about the subjects' experience in a learner control environment and about decisions they made such as whether or not to exit. Twenty interviews were subsequently transcribed for analysis. Three of the original 25 interviews were inaudible and two subjects who had been interviewed scored in the middle curiosity group and thus were not in the sample for analysis purposes. Fourteen interviews were conducted by one of the authors and the remaining interviews were split up between the administrators.

Through random chance, 11 subjects interviewed were male and 9 were female, 12 subjects were high curious and 8 were low curious, 10 subjects were first graders and 10 subjects were second graders. Nineteen subjects had received the Advisement lesson while 1 subject had received the No Advisement lesson. The subject who received the No Advisement lesson was a first grade high curious female.

Lesson Log

The lesson log was completed by the administrator while the subject was engaged in the lesson. The administrator observed certain decisions made by the subject and recorded the data on the lesson log. The information included data on sequencing decisions, exiting decisions, remediation decisions, reaction to advisement, and how many times each subject used the "Stop and Look" learner control option.

Scoring for lesson log. The data for the lesson logs were recorded by the administrators on the logs. The number of times each subject made the various decisions were later tallied.

Procedures

A number of procedures were related to the conduct, setting, and situational organization of the study. Additionally, certain procedures and precautions were undertaken to protect the study's internal validity.

Administration

Curiosity measures. One month before the subjects in the main study participated in the CBIV lesson, they were administered curiosity measures to determine their trait curiosity level (specific). These measures were administered by one of the authors in a group setting in the actual classrooms of participating subjects. The data for the two measures were collected over four days within a one-week time period. Each instrument was administered to one classroom at a time. The six teachers participating in the study determined the schedule for administration in their respective classrooms. The *Which To Discuss Test* was the first instrument administered and the *SCSPG* was the second. The tests were administered on different days to control for fatigue as a confounding variable. The reason for the order of administration of the two measures was that the *SCSPG* required more time to administer and more listening skills on the part of the students. Since these subjects' test taking experience was limited (especially the first graders) the decision was made to give them the less demanding test first.

Subjects' curiosity scores were collapsed into the categorical variable of high or low curiosity and were assigned to either the learner control without advisement treatment or the learner control with advisement treatment. Block randomization on the curiosity variable was used to accomplish this. As mentioned earlier, the middle scorers (n = 11) were dropped in deriving the high and low groups and an independent means t-test showed the difference between the high and low groups to be significant at the p =.0001 level. To test that there were no significant differences between the highs in their assignment to the two treatment conditions, and likewise between the lows, ANOVA was used. Results of this analysis indicated that there were no significant differences between the two treatment groups after being assigned the high curious subjects, p = .77. There were also no significant differences between the two treatment groups after being assigned the low curious subjects, p = .85.

Treatments. Subjects were administered the treatments individually and received a pre-lesson warm-up to familiarize them with how to use the touch screen and to introduce several icons which the subject would encounter during the treatment. The achievement test was administered immediately following the treatment. Audiotaped interviews of randomly selected subjects were conducted following the achievement test. As the concluding activity before being returned to class, each subject viewed the same brief entertaining video at a separate laserdisc station. It lasted approximately three minutes. This activity was meant to serve as a distractor from the main content (and learner control condition) of the lessons to help protect the study from the potential for contamination. Since the video was the last thing each saw, it was likely to be the first and most discussed aspect of their experience.

Three treatment administrators were trained during a half-day session two weeks prior to the study. By employing three administrators to administer treatments it was possible for three subjects to participate simultaneously at separate interactive video stations. The interactive video stations were located in a large room within the school the subjects attended. Large dividers separated each station insuring each subject's individual effort and decreasing distractive elements.

All administrators were paid a daily fee for both the training day and the administration days. A total of six administration days over a two-week period was necessary to administer the treatments, achievement tests, and to conduct interviews.

Procedures: Protection of Internal Validity

A number of precautionary administration procedures were undertaken in the bridge study to protect the study's internal validity. These provisions were replicated in the present study. Subjects were blind to which treatment they were receiving. Both treatments were interactive. Administrators were hired for the treatments and post test to control for experimenter bias. Measures were taken to control for distractions during treatments. Administrators participated in a half-day training session in which they eventually reached 100% inter-rater agreement on reporting the data during a beta test. All treatment administrators were blind to the hypotheses of the study. No one had any prior knowledge of the curiosity ratings of any child before administering the treatment and had no idea about any of the expected interactions. Because administrators had to load the designated lesson on the computer for each subject, they necessarily had knowledge of which lesson they were administering, however.

Research Design

To test the predictions that a) subjects in the Learner Control With Advisement treatment (Advisement) will score significantly higher on a posttest of achievement than subjects in the Learner Control Without Advisement treatment (No Advisement), and b) high curiosity subjects will score significantly higher on a posttest of achievement than low curious subjects regardless of treatment, a two-way analysis of variance was conducted. An alpha level of $\underline{p} \leq .01$ was selected.

To test the prediction that there will be an interaction between curiosity of students and lesson treatment, pairwise multiple comparisons were made choosing a .05 level of significance. These follow-up analyses utilized the Newman-Keuls procedure.

This analysis entailed partitioning the continuous variable of curiosity into the arbitrary categories of high and low curiosity. According to Pedhazur (1973), there is danger in categorization since it can lead to a loss of information resulting in a less sensitive analysis. In essence, all students who were placed in one group or the other were treated as if they had the same score. So that the difference of just one point would not be the deciding factor in group assignment, the three middle scores were eliminated. As reported earlier, this resulted in a loss of 11 subjects but a highly significant p value in differentiating the two groups ($p = .0001$). All 84 subjects were administered the treatments, however, as not doing so would have raised suspicions (and anger) among the subjects left out of this phase of the study.

Block randomization of subjects to the treatment groups was used to control for differences in prior knowledge of museums, ability level, and other factors.

RESULTS

Analysis

A 2 X 2 analysis-of-variance factorial design was computed to test whether performance on the achievement test was related to the treatment, curiosity, or the interaction of treatment and curiosity. Since there were unequal numbers in the cells, the general linear models procedure was used. The results indicated that there was overall significance in the model, $\underline{F}(3,67) = 3.54$, $\underline{p} = .0191$. There was a significant main effect for curiosity ($\underline{p} < .01$). There was no main effect for treatment. No significant interaction was found. Results of this analysis are reported in Table 1. Type III Sums of Squares are reported in the table since unequal sample sizes were used.

Subjects in the Advisement treatment scored only marginally and non-significantly higher ($\underline{M} = 15.62$) than subjects in the No Advisement treatment ($\underline{M} = 15.22$). The hypothesis that subjects in the Learner Control with Advisement treatment would score significantly higher overall than subjects in the Learner Control Without Advisement treatment was not supported. Table 2 presents the means, standard deviations, and range of scores on the achievement test for the two treatments. The standard deviations were virtually the same for each treatment. The range of scores was quite similar in both treatments as well. While there was no *overall* significant difference between treatments, there was, however, a significant interaction between grade level and treatment, $\underline{F}(1,63) = 4.43$, $\underline{p} < .05$. Post hoc comparisons using the Newman-Keuls Test showed that first graders in the Advisement treatment ($n = 18$, $\underline{M} = 16.39$) scored significantly higher than first grade students in the No Advisement treatment (n = 21, M = 12.33). The opposite was true for the 2nd grade subjects with those receiving No Advisement (n =16, M = 19.00) performing significantly better than those receiving Advisement (n = 16, M = 14.75). Figure 3 illustrates this interaction.

Table 3 presents the descriptive statistics for the achievement test score based on curiosity. The difference in mean scores on achievement between the two groups is quite large (difference = 5.03 points) in favor of the high curiosity group. Therefore, the hypothesis that high curious subjects would perform better in an interactive learner control lesson than low curious subjects regardless of treatment was supported. Overall, high curious subjects received significantly higher scores on the achievement test (M = 17.89) than low curious subjects (M = 12.86). The range of scores also reflects a dramatic difference with the highest score in the high curiosity group and the lowest score in the low curiosity group.

Table 4 presents the descriptive statistics for the achievement test scores by treatment and curiosity groups. High curious subjects performed slightly better, although not significantly, in the No Advisement treatment (M = 18.39) than they did in the Advisement treatment (M = 17.39). Also, high curious subjects in the No Advisement treatment scored significantly higher (M = 18.39) than low curious subjects in the Advisement treatment (M = 13.63) at the p < .05 level with the Newman-Keuls test. Low curious subjects did score higher in the Advisement treatment (M = 13.63) than low curious subjects in the No Advisement treatment (M = 12.21) but the difference was not significant at the p < .05 level (see Figure 4).

There were no main effects for grade level although second graders achieved higher scores (n = 32, M = 16.88) than first graders (n = 39, M = 14.20) on the achievement test. There was also no significant interaction between grade level and curiosity on performance on the achievement test suggesting that curiosity was not affected by the higher level of verbal and communication skills of the second graders.

There was no significant main effect for gender. Males and females performed equally regardless of which lesson treatment they received. Most importantly, however, no interaction between gender and curiosity suggests that curiosity is not affected by gender differences. High curious females (n = 18) scored only slightly higher (M = 18.17) than high curious males (n = 18, M = 17.61) while low curious males (n = 13) scored slightly higher (M = 13.15) than low curious females (n = 22, M = 12.68).

Table 1

Analysis of Variance Tests of Hypotheses

Source	df	SS	MS	F
Curiosity	1	436.91	436.91	9.77*
Treatment	1	0.76	0.76	0.02
Curiosity*Treatment	1	25.77	25.77	0.58
Error	67	2997.16	44.74	

* p < .01

Table 2

Achievement Test Scores: Descriptive Statistics by Treatment Group

Variable (treatment)	N	Mean	Std. Dev.	Minimum Score	Maximum Score
No Advisement	37	15.22	7.17	4.00	40.00
Advisement	34	15.62	7.00	3.00	38.00

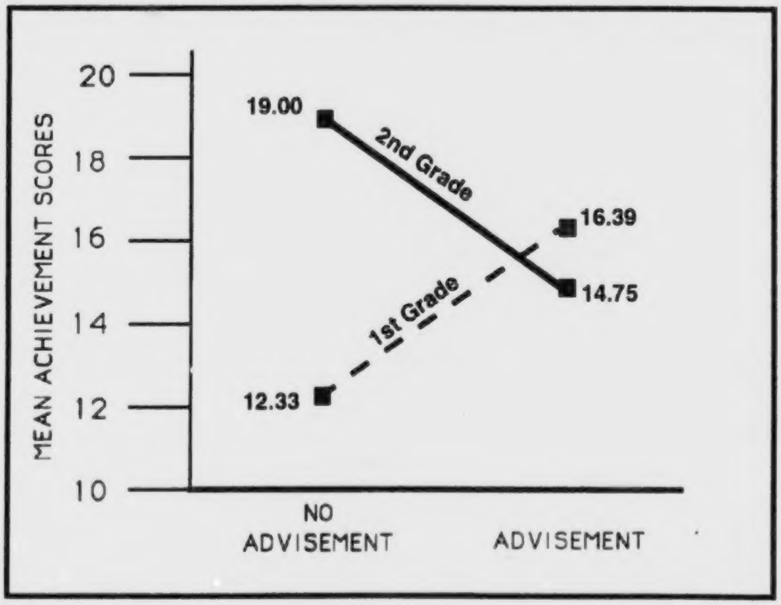

FIGURE 3 □ Mean Achievement Scores by Treatment and Grade Level

Table 3

Achievement Test Scores: Descriptive Statistics by Curiosity Groups

Variable (Curiosity)	N	Mean	Std. Dev.	Minimum Score	Maximum Score
Low	35	12.86	5.98	3.00	29.00
High	36	17.89	7.19	8.00	40.00

Table 4

Achievement Test Scores: Descriptive Statistics by Treatment and Curiosity Groups

Variable Treatment	 Curiosity	N	Mean	Std. Dev.	Minimum Score	Maximum Score
No Advisement	Low	19	12.21	5.58	4.00	23.00
	High	18	18.39	7.43	8.00	40.00
Advisement	Low	16	13.63	6.52	3.00	29.00
	High	18	17.39	7.11	8.00	38.00

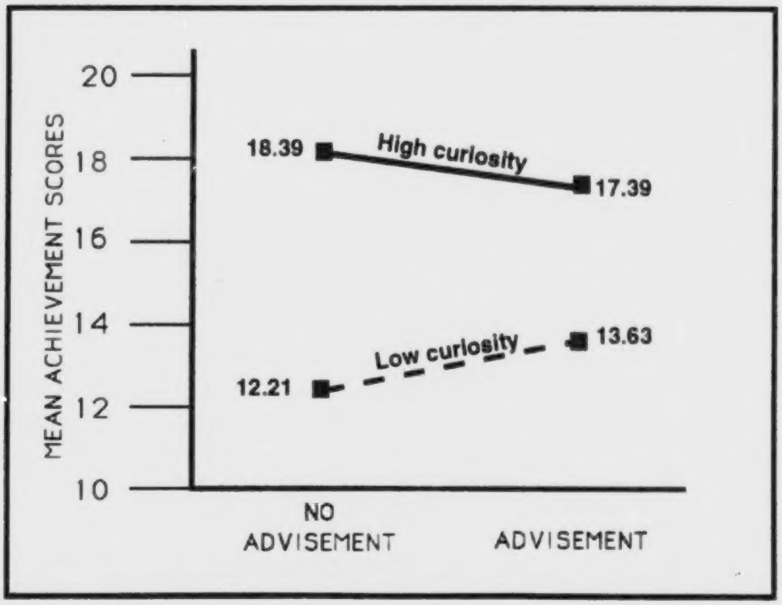

FIGURE 4 ☐ Mean Achievement Scores by Treatment and Curiosity

In-Treatment Data: Time on Task, Curiosity, and Treatment

Time on task is the actual length of time the subject spent in the lesson; therefore, the time spent in the pre-lesson warm-up or the time spent in administration of the achievement test was not included. After the subject received a pre-lesson warm-up which averaged 3.26 minutes, the narrator instructed the subject to "touch the screen when you are ready to begin your visit." The computer tallied time in treatment from the moment the subject touched the screen to the conclusion of the treatment. Due to computer error, 9 subjects' time data were lost. To determine if there was a relationship between time on task and treatment, curiosity, and grade level, an analysis of variance was conducted. The analysis indicated that there was overall significance in the model, $F(7,54) = 3.94$, $p < .01$. Significant main effects existed for treatment ($p < .05$) but not for curiosity or grade level at the $p < .05$ level. Subjects in the Advisement treatment ($n = 34$, $M = 15.4$) spent approximately two minutes longer in the lesson than subjects in the No Advisement treatment ($n = 28$, $M = 13.2$). No significant interactions existed at the $p < .05$ level. Figure 5 shows the interaction of curiosity and treatment on time on task.

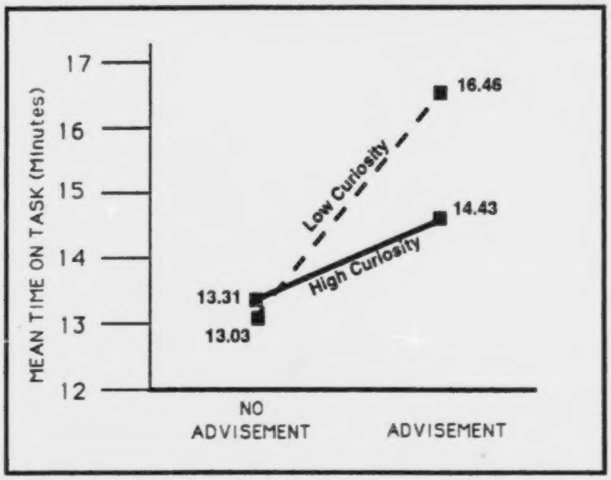

FIGURE 5 ☐ Mean Time on Task: Interaction of Curiosity and Treatment

In-Treatment Data: Learner Control Decisions

In addition to time on task, in-treatment data collected included decisions made by the subject related to other learner control options such as sequencing, remediation, "Stop and Look," and exiting, as well as subjects' response to advisement.

Sequencing. Most subjects availed themselves of the opportunity to sequence their material. Eighty-nine percent (89%, n = 63) of the subjects chose a sequence of content presentation different from the sequential order of the menu options. Only 11% (n = 8) of the subjects chose the sequential order of menu options. Thirty-seven and one half percent (37.5%, n = 3) of these children were in the high curious group while 62.5% (n = 5) were in the low curious group.

Exiting. Almost all of the subjects (87%, n = 62) stayed in the lesson. Of the 13% (n = 9) that chose to exit, 56% (n = 5) were low curious while 44% (n = 4) were high curious.

Remediation. Most children either did not require remediation or chose remediation when it was offered the first time. Of the 71 subjects, 20 subjects (28%) needed remediation and were asked if they would like to receive remediation after an incorrect response. Sixteen of those subjects (80%) chose to be remediated when it was offered. Four subjects (20%) responded "No" to the offer of remediation. Two of those four were in the Advisement treatment and both decided to be remediated *after* receiving the advisement.

Advisement. When advisement was offered, it was most often heeded. Unfortunately, most children did not get to that point. Of those who exited and then received advisement to return to the lesson (n = 6), 67% heeded the advisement and returned to the lesson while 34% (n = 3) chose to ignore the advisement.

As discussed under remediation, only two children who chose not to be remediated were in the advisement treatment. Both those children heeded the advisement and ultimately received the remediation.

"Stop and Look" and "Stop and Think" were the other forms of advisement which were built into the lesson. While only the Advisement treatment offered the opportunity to "Stop and Think;" both treatments offered the opportunity to "Stop and Look;" the advisement treatment, however, included encouragement to "Stop and Look" as well. The next section discusses the results of the analysis of this particular advisement.

Effect of "Stop and Look" advisement. While second graders showed little difference in the mean number of times they used the "Stop and Look" option between the No Advisement treatment ($M = 1.37$) and the Advisement treatment ($M = 1.50$), the difference between the first graders in the No Advisement treatment ($M = .95$) and first graders in the Advisement treatment ($M = 2.33$), warranted closer examination. An independent means t-test was conducted with the first graders to determine whether there was a significant difference between the means of the two groups in use of "Stop and Look." The results were significant at the $p < .01$ level. It appears that the first graders, then, actually ***heeded*** the advice to "Stop and Look" more so than did the second graders. Figure 6 illustrates this interaction.

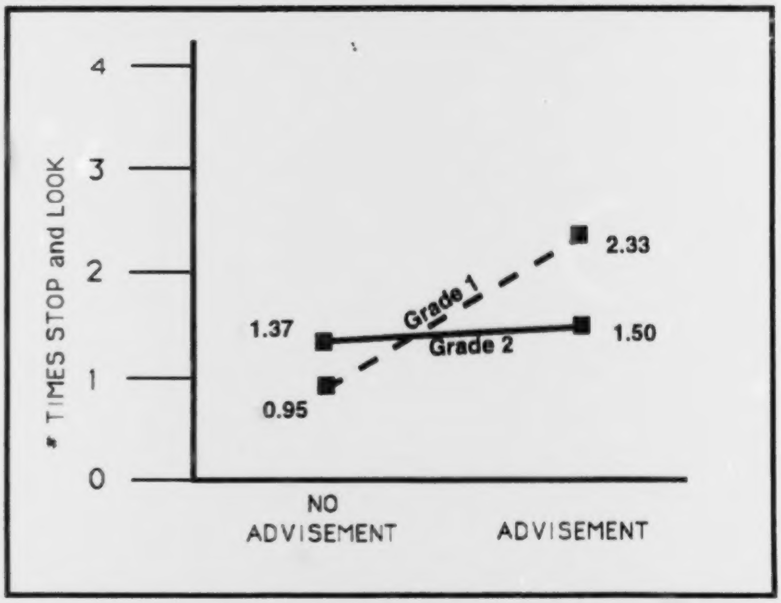

FIGURE 6 ☐ # Times "Stop & Look" Option Used By Grade Level and Treatment

Qualitative Data

Interview data were collected from a random selection of 25 subjects. The interviews were audiotaped. From the 25 subjects interviewed, twenty were transcribed for review; three of the original 25 were in the middle curiosity group who had been dropped from the analysis, and the two remaining subjects' audio recordings were inaudible. The 20 subjects accounted for 28% of the total sample. Through random chance, 12 subjects interviewed were high curious while eight subjects were low curious, 11 were males and 9 were females, and 19 had received the Advisement lesson while 1 received the No Advisement lesson. There were 10 first graders and 10 second graders.

The interview was conducted following the treatment and achievement test, and prior to the concluding entertainment video. The purpose of the interviews was to collect data on how subjects felt about the lesson in general, how subjects responded to a learner control environment (since both treatments represented a learner control environment), and why subjects made certain decisions. The interview also provided an opportunity to confirm whether or not the child actually understood the learner control options and assess his/her opinion about them. The average interview lasted approximately 4-5 minutes. In terms of the results, the most explanatory qualitative information received pertained to one of the learner control options, the opportunity to "exit." It must be noted, however, that almost all who were interviewed had received the Advisement lesson which may have influenced them to stay in the lesson.

Overall response to lesson. With the exception of one "I don't know" response all the subjects interviewed had a favorable reaction to the lesson. The most common responses were "It was fun" and "I liked it" when asked what they thought about the lesson they had just finished. When queried further, the subjects varied in what they considered "fun" about the lesson. Some subjects enjoyed the technological aspects of the lesson such as the opportunity to "touch" the computer screen and make things happen, while other subjects actually mentioned the content as in "...My favorite part about it was the big sculptures at the beginning, and the artists were neat and the different kinds of portraits and stuff."

Exiting. Most children did not exit the lesson as indicated by the lesson log completed by the administrators. This undoubtedly contributed to the lack of treatment effects. Had more children exited, it would have been possible to determine the effect of advisement on their decisions to re-enter the lesson or not. The interviews helped to explain why more children never got to this advisement. Typically, the children responded that they did not exit because they either were enjoying their experience or were interested in what else would be coming up in the lesson. Again, the children interviewed were mostly in the Advisement lesson and may have felt more comfortable about staying in the lesson as a result. Only 13% of the 71 subjects chose to exit. The following is a typical exchange of those interviewed.

Interviewer
Remember that big red button?

Child
Yeah. That was the exit.

Interviewer
That's correct. You never touched that exit button. Why didn't you ever press the exit button?

Child
I don't know. I just wanted to see what else was there.

The above excerpt was taken from an interview with a high curious child. The responses from low curious children were similar. The following excerpt is from an interview with a low curious child.

Interviewer
I noticed that you didn't use the big red button. Do you remember that red button?

Child
Yeah.

Interviewer
What did that red button stand for?

Child
Um, if you didn't want to do that anymore.

Interviewer
That's right. You could what?

Child
Stop.

Interviewer
Stop. You could just get right out of the lesson. But, you never pushed that red button. How come?

Child
Because I liked it.

A particularly enthusiastic second grader (high curious) had this exchange with the interviewer:

Interviewer
Did you ever exit, touch the red button?

Child
No.

Interviewer
How come?

Child
Because I thought it was really interesting just looking at what I picked. I didn't even pay any attention [to the red button] it was so cool. I just liked what I picked.

Learner Control. Regardless of whether a child was in the Advisement or the No Advisement treatment, they were functioning in a learner control environment in which they had to make decisions about their own learning. The children were asked about what it felt like to make their own decisions as well as asked what kind of decisions they made. It should be noted once again that more high curious subjects were interviewed than low curious subjects so it is difficult to make general statements regarding the low curious subjects.

All high curious subjects and five of the seven low curious children enjoyed being able to make their own decisions in the lesson. When queried, most of them remembered at least some of the actual decisions they made such as the order in which they selected the content or whether they used options such as "Stop and Look." The first exchange takes place with a low curious female who had received the Advisement treatment.

Interviewer
In a lesson like this, you get to make lots of decisions. Like what you will learn about, whether to exit, whether to practice more if you get a wrong answer, and things like that. In this lesson, you're the boss. What does it feel like being the boss? [making decisions in the lesson]

Child
It feels good. Like you're controlling yourself.

Interviewer
Is that a good feeling being able to control yourself?

Child
Yeah.

Interviewer
Do you get to do that much in your life at your age?

Child
Well...[pause]...not always. Like if I go in my room, I have a sign on my door that tells people that they have to knock. And then I can control myself when I'm in the room, but, like in school I have to do certain things and stuff like that.

Interviewer
And how is this [lesson] different?

Child
Well, you can choose the things that you want to do and that you would like to see...

The reference to "control" was used by this high curious male subject as well...

Interviewer
...What was that like...to be the boss?

Child
It was like I was controlling the whole world or the country.

Interviewer
And how did that feel to you?

Child
It felt like I was George Washington or the Governor of the World!

The low curious female in the following excerpt did not like the idea of exploring information on her own.

Interviewer
Do you like people telling you about the information, or do you like to investigate and find information out yourself?

Child
I like people telling me...

The qualitative data although sampling only 28% of the subjects, helped to illuminate issues such as the lack of treatment differences.

Overall, the high curious children in this study responded to an interactive learner control environment more effectively than the low curious children regardless of which lesson they received as indicated by performance on an achievement test related to the lesson content.

DISCUSSION

The emergence of interactive learning technologies provides educators, designers and developers with an opportunity and a challenge to meet the individual needs of different types of learners. To achieve desired instructional outcomes, the educator or designer must consider various *instructional variables* in order to prescribe an appropriate instructional method (Reigeluth, 1983). For this study, the instructional variable explored was learner curiosity. The method explored was learner control. Learner control as it relates to individual differences is an important issue. While research exists in the separate areas of learner control and curiosity, there is little known about the relationship between these variables and what effect they have on learning.

This study built upon the Arnone and Grabowski (1992) research on the effects of variations in learner control on young children's learning. That study showed that young learners demonstrated significantly better achievement in a learner control lesson which incorporated advisement than one in which the learner received no advisement.

The Arnone and Grabowski (1992) study did not look at individual differences in trait curiosity. A learner control environment might be experienced differently by individuals who vary in trait curiosity. The curiosity research suggests that individuals have different tolerance levels for arousal potential (Day & Berlyne, 1971). Varying degrees of learner control, then, may present different levels of arousal potential depending on the individual. Examination of the two separate literatures provided a basis for a conceptualization of a theoretical framework for the hypotheses presented in the study.

Curiosity

Curiosity and Learner Control

High curious subjects were predicted to perform better than low curious subjects in either learner control environment. High curious subjects, having a higher tolerance for uncertainty and the unfamiliar, should be more efficient in a learner control environment. Low curious subjects, on the other hand, may feel overstimulated or become anxious or disinterested in such a learning situation. The results of this study supported that prediction ($p < .01$). High curious children achieved significantly higher scores on an achievement test than low curious children after being exposed to a learner control lesson, regardless of treatment. This would support the theoretical argument that individuals have different optimal levels of arousal. What is the appropriate amount of stimulation for one person may not be enough or may be too much for another.

In addition to the art education content, a certain amount of arousal inducing stimuli were present in this lesson by virtue of its being a learner control environment. Such stimuli included use of touch screen, choice of menu options, and use of other learner control options such as pacing, remediation, exiting, "Stop and Look" and, in the Advisement lesson, the length of time to spend in the "Stop and Think" mode. Taken together, the stimuli described above could be considered rather high in *collative variability*, a construct used by Berlyne (1960. *Collative variability* refers to how complex a stimulus is and how easy or difficult it is for the individual to collate, or compare with stimuli with which he/she is already familiar. While collative properties have the potential of increasing arousal level and inducing curiosity, Day and Berlyne (1971) state that different individuals will vary in their preference and tolerance for arousal potential. In this lesson, the high curious subjects were able to function efficiently, both assimilating the content and collating the various stimuli presented via the learner control format.

On the other hand, the low curious subjects may have spent more of their effort in attempting to collate the various stimuli of a learner control lesson which limited their efficiency in terms of assimilating the necessary content. This was reflected in lower achievement scores.

The results of this study provide some evidence to demonstrate that curiosity is an important factor in either learner control environment. These high curious students functioned better in this situation than the low curious students. However, it is not known how these high curious students would have performed in a program control environment. The high curious subjects hypothetically would perform less well in a program control environment because the amount of stimuli would be *less* than optimal for them. For the low curious students, program control may have the appropriate amount of stimuli for them, resulting in more efficient learning. In the present study, it is likely that the low curious subjects experienced both treatments as at least somewhat high in degree of uncertainty. Further research is needed to explore this as well as research to investigate the effect of low uncertainty (e.g., program control) on learning in low curious subjects since this study did not include program control. Fry (1972), for example, found that high aptitude/highly inquisitive subjects learned significantly more in what that author called a high degree of student control (what is referred to as learner control in this study) while high-aptitude/low-in-inquisitiveness subjects performed significantly better given a low degree of student control.

Alternative Explanation: Why Subjects Did Not "Exit"

Earlier, several explanations were offered to explain why more subjects did not exit the lesson. (By not exiting, they never received the advisement pertaining to the exit decision which lessened the effect of the Advisement treatment.) One suggestion was that most children did not leave because they were engaged in the lesson and simply wanted to remain in the lesson. The randomly selected interviews, representing 28% of the sample, substantiated this. (It should be repeated that only eight low curious subjects as opposed to 12 high curious subjects were interviewed, and most subjects interviewed had received the advisement lesson.) Exiting would have provided the low curious subjects a means to limit their stimulation by actually withdrawing from the source of it, the learner control lesson itself. Yet, 85% (n = 31) of the low curious subjects remained in the lesson. The following paragraphs offer an alternative explanation for why more low curious subjects did not exit.

Since the subjects in this study were young and inexperienced, exiting the lesson might have represented to them a choice that was even more unfamiliar to them than the lesson itself which provided them with some regularity of format and presentation. In other words, the longer they stayed in the lesson, the less likely it became that they would exit since some of the uncertainty of a learner control environment diminished simply as a result of staying in the lesson. For example, as more time was spent in the lesson, they became familiar with the sound of the narrator's voice, and with the format of practice items and with touching the screen. The lesson itself became the more familiar scheme while the red exit button may have embodied an object of uncertainty. Not yet having touched it, it was something that might have represented some cognitive conflict: what really would happen if the red button were touched?--perhaps the screen would become black, perhaps it would mean an immediate return to the classroom, and so on.

Even though they had been told in the pre-lesson warm-up that the lesson would end if they touched the red button, if they had never actually done it in the lesson, it would represent an unexplored stimulus.

If the above explanation is true, it would follow that an individual who prefers a lower level of arousal would choose to ignore this thus far unexplored and therefore unfamiliar button, a button which posed an additional source of collative variability. This explanation can be related to Day and Berlyne's statement about collative properties and response conflict:

> Collative properties act by inducing a state of *response conflict*, i.e., uncertainty about the nature of the stimulus and thus a conflict among the various response tendencies toward it. (1971, p. 313)

It is possible, then, that uncertainty about the nature of the exit button induced a response in these learners which may have been resolved by avoidance.

Effect of Advisement on Low Curious Subjects

There was a difference of 1.4 points between treatments in favor of the Advisement treatment with low curious subjects. The minimum significant difference was 3.17 and therefore this difference was not statistically significant at the .05 level. The treatments were equalized because students often did not receive the advisements related to exiting and remediation. They did not receive the exit advisement because they did not press the exit button; they did not receive the remediation advice because they generally took the remediation when offered.

The advice to "Stop and Look" in the Advisement treatment did make a difference, however, in the number of times that the option was used by low curious subjects. Low curious subjects responded to the advisement to "Stop and Look" significantly more times in the advisement treatment ($\underline{M} = 2.06$) than did the low curious subjects in the No Advisement treatment ($\underline{M} = 1.16$). The minimum significant difference was 0.826; the difference was significant at the $\underline{p} < .05$ level. This seems to indicate that this advisement in the Advisement treatment did reduce some of the uncertainty associated with that stimulus as compared to the No Advisement treatment. What this suggests overall is that such advisements did make a difference for the low curious subjects in that they responded to them (as evidenced by the use of them), but on its own it was not enough to make a statistical difference in scores between the treatments. It might further be suggested that low curious subjects will respond to advisement if advisement is received. In the case of exiting and remediation, such advisement was not received for most of the subjects.

Perhaps, more such strategies along the lines of "Stop and Look" and "Stop and Think" embedded in the lesson would have cumulatively contributed to making advisement more beneficial to low curious students.

Treatment

Diminished Power of Treatment

One explanation for the lack of a main effect for treatment was that the differences between the treatments were diminished because most subjects in the advisement treatment did not get the full benefit of each aspect of advisement.

Remediation. Most of the subjects in the Advisement treatment took remediation the first time it was offered and thus never had advisement pertaining to remediation. The subjects in the No advisement treatment also took the remediation when offered. This may have contributed to the lack of differences between the groups which would have been attributed to receiving or not receiving advisement on remediation.

Exiting. Another possible reason for no main effect for treatment was that very few children exited the program. In the Advisement treatment, if a child exited, he/she would have received a prompt like this: "Are you sure you want to leave now? There's lots more for you to discover. This next section is very interesting." The advisement, then, gave the child the opportunity to reconsider his/her decision and re-enter the lesson. To receive the advisement, however, the child must first have pressed the exit button. Had more children in both treatments exited, it would have been possible to sense the effect of this advisement on performance in the achievement test. That is, those that heeded the advisement and re-entered the lesson would be expected to demonstrate higher achievement scores than those who did not heed the advisement or did not receive the advisement, thus, missing out on some of the content presentation and spending less time on task.

Questions to be resolved include whether the subjects were too afraid to exit (e.g., they may have had the expectation that they were "supposed" to finish) or whether they were too engaged in the lesson to exit. Because of the careful procedures followed in the pre-lesson warm-up, it seems unlikely that the reason children did not press the red exit button was because of perceived expectations that the lesson had to be completed. Each administrator followed a three-step procedure related to the exit button as follows: 1) introduce the child to the red exit button and explain its function, 2) have the child relate his/her understanding of the button's function (to confirm that child understood the directions), and 3) tell the child that it is permissible to use the exit button anytime he/she wants to end the lesson. The last part of the procedure was very important; it was designed to alleviate the child's potential fear of expectations on the part of the administrator that the child had to finish the lesson. It is equally important to note, however, that while the administrator used the three procedures described above to assure that each child understood the meaning and function of the red exit button, the child would not have the opportunity to **actually** exit until he/she was in the actual lesson.

Some children may not have exited because it would have meant returning to their classroom. Working in the CBIV lesson may have seemed more appealing to them than the alternative. Many children had not experienced interactive video prior to the study, and so the novelty effect may also have contributed to keeping them in the lesson.

Another possible reason that most children did not exit is that they were so engaged in the lesson that they wanted to remain in it. The interviews representing 28% of the children helped to corroborate this explanation. A caution, discussed earlier, remains for this explanation since most of those who were interviewed had received the Advisement lesson; therefore, those receiving the No Advisement lesson were under-represented in the interviews. Part of the interview was devoted to exploring reasons for decisions made by the child. The exiting decision was usually discussed as in "I noticed that you did not use the red button to leave the lesson. Why not?" The most typical response was "I didn't want to. It was fun." It may be that children were engaged by the changing elements in the lesson (e.g., new video segments, new content, etc.) and that they attended more to these changing elements than to the static exit button. The child quoted in Chapter 4 as saying "...I didn't even pay any attention [to the red button] it [the lesson] was so cool," suggests this explanation. Berlyne (1951) states:

> A recently changed stimulus is more likely to be responded to than one which has remained unchanged and has been responded to for some time. (p. 277)

While the exit button would have represented a stimulus which remained "unchanged" as the lesson progressed, it would not have represented a stimulus which had been "responded to for some time" (since most children did not ever respond to the exit button by pressing it). It would thus appear that there may be some other alternative explanation worth investigating. Such an explanation deals with level of curiosity which is discussed later in this chapter.

In sum, not exiting may have had the effect of diminishing the strength of the treatments making them less sensitive to differences due to advisement about exiting decisions.

Power of Treatments Left to Remaining Advisement Strategies

Effectively, the Advisement treatment was differentiated from the No Advisement treatment by the two remaining embedded advisement strategies: 1) "Stop and Look" and 2) "Stop and Think." Although both treatments offered the opportunity to "Stop and Look" at an image whenever a particular icon was present, subjects in the Advisement treatment were also encouraged to use the "Stop and Look" option to explore the images more closely. Subjects in the Advisement treatment were also encouraged to "Stop and Think" periodically as in "What do you suppose you'll find when you go in [the museum]? 'Stop and Think' about it. Then touch the screen when you are ready to go on."

Without the contribution of the remediation and exiting advisements in the Advisement treatment, the strength of the treatment fell to the above remaining advisement strategies. It seems likely that these strategies were not enough on their own to sense the effect of advisement versus no advisement as a main effect. It may be that the two treatments were equalized, in effect, by the subjects' enjoyment of the lesson. It might also have made a difference overall had more embedded advisement strategies been incorporated in the treatment.

Explanation of Grade by Treatment Interaction

Although the power of the treatment may have been diminished overall, the first grade subjects performed significantly better with Advisement than with No Advisement. The opposite was true and significant for second graders. A possible explanation for these results pertains to the remaining advisement strategies and their effect on the younger subjects.

Interpretation of results with first graders. Examination of the in-treatment data showed that the first grade subjects heeded the advisements to "Stop and Think" and "Stop and Look" more so than the older subjects. Evidence supporting this supposition was collected for one of these advisements. Although no data were collected on the time spent in the "Stop and Think" mode, data were collected on the number of times a subject used the "Stop and Look" learner control option. Grade 1 children in the Advisement treatment did use the "Stop and Look" option more times ($M = 2.33$) than did grade 1 children in the No Advisement treatment ($M = 0.95$). The difference was significant at the $p < .05$ level using the Newman-Keuls procedure. More importantly, first graders in the Advisement treatment also used the "Stop and Look" learner control option significantly more times than their second grade counterparts in the same treatment ($M = 1.50$), $p < .05$. These in-treatment data suggest that the first graders actually heeded the advisements to a greater degree than the older subjects and may be partly responsible for the better performance of first graders over second graders in the Advisement treatment.

Why would first graders heed advice more than the second graders? One possible explanation is related to the newness of the academic experience for these younger subjects. The first graders were less experienced and may have perceived the voice of the narrator as a reassuring adult authority figure offering encouragement to explore images carefully and to "Stop and Think." They may also have required more guidance as their experience with computers was minimal compared with the second graders.

Interpretation of results with second graders. With second graders, the explanation of the grade by treatment interaction is more nebulous. There was no significant difference between treatments in the use of the "Stop and Look" learner control option with second graders. The second graders actually performed better in the No Advisement treatment than in the Advisement treatment. Why did second graders not heed the advisements as much as the younger subjects? One possible explanation is that computer-based instruction was not as new to these subjects; they perhaps did not sense the need for encouragement from the narrator as much as the younger subjects. Additionally, second graders had more experience with computers in the classroom and may have felt that they were more experienced users and did not need to follow the advice.

What the results seem to indicate is that when advisement is heeded, as in the case of the first graders, it does make a difference. When it is not heeded, as in the case of the second graders, it seems likely that learners can do just as well or better in a learner control lesson without advisement. Furthermore, it seems likely that younger subjects will heed advisement more than older subjects.

Comparison to Bridge Study

This study was at odds with the bridge study in that no main effects for treatment were found. However, the overall significant differences for the bridge study were very closely replicated in the first grade population of the present study. That is, the mean score for subjects in the learner control with advisement treatment in the bridge study was 16.08, while the mean score for first graders in the present study was 16.39. The mean score for the learner control without advisement treatment in the bridge study was 13.35 while the respective score for first graders in the present study was 12.33.

The anomaly seems to have occurred with the second graders who performed contrary to expectations. The bridge study did not isolate the grade variable so comparisons across studies by grade are impossible. However, upon close scrutinization of the data for the present study, an interesting pattern emerges. There were more high curious subjects in the second grade (n = 20) than in the first grade (n = 12). There were also more low curious subjects in the first grade (n = 23) than in the second grade (n = 12). Furthermore, there were more high curious second graders in the No Advisement treatment (n = 10) than there were low curious second grade subjects in the No Advisement treatment (n = 5). It is possible, then, that the high curious subjects who predominated in the No Advisement treatment in the second grade contributed to the unexpectedly high scores in the No Advisement treatment with second graders. Since high curious subjects were expected to experience greater ease in handling the uncertainty of the No Advisement treatment, this is one possible explanation for anomaly which occurred.

Implications for Instructional Design

This study provided empirical support for the hypothesis that high curious children learn better in two types of learner control lessons than low curious children. Such information has implications for the design of instruction whether the delivery of that instruction is in a classroom or via interactive technologies. Based on the findings, it is recommended that educators and designers acquire knowledge about the individual differences in curiosity level among students and determine appropriate methods and strategies to maximize learning in each individual student. If, for example, it is known that a particular child is very low curious, then the child may be overwhelmed in any learner control environment at this point. A high amount of guidance in the way of instructor (classroom) or program (CBIV) control of the lesson would be recommended. In other cases, where the child is mid-to-low in curiosity, a learner control lesson with many embedded strategies to reduce uncertainty and bring the lesson in line with the child's optimal level of arousal potential would be appropriate. A high curious child should feel comfortable in an environment with moderate to high amounts of learner control.

Based on the superior performance of the first grade subjects in the Advisement treatment in this study, and the results in favor of advisement in the Arnone and Grabowski (1992) study, advisement is recommended in a learner control lesson designed for young learners. What seems to be even more important, however, is that advisement must be heeded in order to be successful. Strategies, therefore, must be employed which also encourage students to *heed* advisement.

Suggestions for Future Research

Research needs to be conducted which addresses some of the limitations of the present study. Since the power of the treatments was diminished by the fact that subjects did not use all the advisements, a future study could strengthen the respective treatments by including more learner control options and more opportunities for advisement. In this way, the loss of two advisements as was the case in the present study (i.e., exiting and remediation) would not be as detrimental to sensing the overall effect of the treatments.

Perhaps, research needs to be undertaken which explores who takes advisement and who does not, as well as what strategies are most effective in inducing students to heed advisement. Future studies should also include program control. Although this study predicted that low curious subjects would perform better in an environment where there was less collative variability, program control was not included. Program control would take the learner along a predetermined path and might substantially reduce the uncertainty of the learning environment. A study which includes program control in addition to variations in learner control could be used to investigate the effect on learners of the full range of uncertainty in learner control as depicted in Figure 2.

More psychometric studies need to be conducted to collect data on the curiosity instruments, especially the *Specific Curiosity Scale for Primary Grades (SCSPG)* so that the instruments can continue to be improved in terms of their validity and reliability in measuring curiosity in young subjects.

Is it possible that, with repeated exposure to a learner control environment, the uncertainty associated with this type of learning environment would be reduced? It would seem that low curious subjects might then improve their performance as they became more familiar with the types of stimuli associated with a learner control lesson. These stimuli would include the learner control options in addition to the specific content presented. To research this question, a study could be designed which collects data over time on the use of learner control lessons and the changes in achievement with increased exposure. A variation of this suggestion would be studies which, using program control initially, gradually reduce the amount of program control while increasing learner control so that learners build up to tolerating higher levels of uncertainty.

Future studies should also be planned which explore the potential for increasing trait curiosity level over time. Berlyne (1960) discussed several studies in which stimuli previously associated with supraoptimal arousal for a child became optimal as the child's experience with the situation increased. A learner control study could, for example, be undertaken which examines the effectiveness of particular instructional design strategies designed to enhance state curiosity (e.g., encouragement to explore with guidance provided, use of questions to arouse interest, encouragement of question-asking behavior, provision of environment in which experimentation can occur, etc.) and determine whether trait curiosity can be enhanced over time through repeated experiences in which state curiosity is increased. In conjunction with the same study or a subsequent study, changes in trait curiosity should be correlated with changes in achievement to determine if there is a significant positive relationship between these two variables as would be predicted.

Finally, the use of physiologic measures may provide physical evidence of an individual's curiosity as measured by arousal during a CBIV lesson. Clariana (1990) found GSR to be correlated highly with measures which are of interest to researchers in the field of instructional design. For example, Raskin (1973) used GSR as a measure of attention. Other researchers have found strong correlations between GSR and attitude self-reports and preference (e.g., Schwartz & Shapiro, 1973).

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Title:

Wide-Area Network Resources for Teacher Education

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Wide-Area Network Resources for Teacher Education

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Imagine leading a classroom discussion and being able to immediately display any text, instructional software, or video resource that fit the direction of an evolving debate. Later your students engage in an inquiry activity supported by information that they gather from immense network data bases on such topics as population demographics, employment statistics and longitudinal national weather records. Finally, you consult your personalized electronic newspaper and send an E-mail question to the author of an article that describes an alternative data base inquiry activity. Such scenarios may soon be actualized through recent advances in computers and the improving climate toward establishing wide-area national networks.

On December 9, 1991, the president authorized the High Performance Computing (HPC) Act. For 1992, legislature appropriated nearly $600 million to eight agencies (DARPA, NSF, DOE, NASA, EPA, NIST, NOAA and Education) in support of HPC. If fully appropriated, federal funding for HPC from FY 92 to FY 96 will approach 3 billion dollars. A central function of HPC is to establish the necessary policy and resources for implementing a National Research and Education Network (NREN). Among other goals NREN will seek "...to expand the number of researchers, educators, and students with training in high-performance computing and access to high-performance computing resources; and to promote the further development of an information infrastructure of data bases, services, access mechanisms and research facilities ..." (Public Law 102-194; section 3,1).

NREN will greatly improve the volume and speed with which the rapidly growing pools of electronic–based information are delivered. By 1996, NREN will be capable of transmitting at least a billion bits (gigabits) per second (Gore, 1991), thereby opening a new gateway to a vast array of electronic-based information resources. What level of access do teachers and teacher educators need to benefit from this electronic superhighway? What kinds of network resources are most useful for educators? What design issues are crucial for the successful implementation of networking in schools?

The UNITE system

This paper discusses factors to consider when developing wide-area network resources for educators. Some of the recommendations come from experience and research compiled over a two year period in association with the Unified Network for Informatics in Teacher Education (UNITE) networking project that was initiated through a grant from the Apple Corporation. UNITE is a prototype for linking educators who are geographically separated but share common goals for advancing teacher education. UNITE targets four constituencies concerned with teacher education: student interns, classroom teachers, administrators and teacher educators. These constituencies exchange ideas through electronic mail and community published resources on instructional software, lesson plans, field trips, mentor profiles and research abstracts. The UNITE stations are located in the school's library or staff development area. A school-based liaison team, consisting of an administrator, a teacher, a librarian/computer specialist and if available, a teacher education intern, monitors use of the stations. Student involvement with UNITE centers on cross-school discovery activities intended to extend data collection and analysis across content, grade levels and schools.

In September 1989, dedicated UNITE stations consisting of a Macintosh SE, modem and printer, were established in six secondary, five middle and five elementary schools representing six eastern Kansas school districts. The schools connect to the hub computer at the University of Kansas for updating the mail and resource files. The transmission speed is slow (1200 baud). However, the system is capable of emulating the immediacy of faster transmission speeds by making transfers at night and using the local hard drives for storing files. The disadvantage of this method of distribution is that the quantity of immediately available resources is limited to the size of the local hard drives. Also, as a prototype that has seen many changes to accommodate user preferences, reliability has suffered and we are considering "freezing" the system in a more dependable configuration. The following recommendations are for extending navigational aids, such as UNITE, to take advantages of the growing quantity resources available through wide-area networks.

Expectation Management

Introduction of educational innovation requires a delicate balance between enthusiasm and realistic goals. On the one hand, administrative support is needed to launch innovative projects but too much enthusiasm can breed unrealistic expectations. Obtaining this balance can be especially challenging, given the administrative procedures for allocating projects within local educational agencies and because there are unique reward systems for school of education faculty, practicing teachers and school administrators.

During the initial administrative orientation, presenters explained that the UNITE resource catalogs begin as "empty" vessels to be filled over time by the constituents. Even with this explanation, messages conveyed to some teachers suggested that a complete compendium of resources would be available shortly. When introducing innovation, developers should consider a separate session for administrators that explicitly deals with the importance of expectation management. Network representatives may also wish to stipulate that the participating schools must demonstrate an intact support system for computer maintenance and training before establishing wide-area services.

Establishing Local Links to Wide-Area Networks

Each of the 17 participating K-12 schools has a single UNITE station. We used the approach of distributing stations across several schools, as opposed to more stations in fewer schools, in order to gain feedback from a variety of grade levels in urban, suburban and rural settings. As the project progressed, an increasing number of teachers expressed the need for network connections from classrooms. These teachers explained that classroom network access would allow them to use the network more frequently and offer more opportunities for student involvement.

Many advances in connecting computers have emerged since the beginning of the UNITE project and networking cost have decreased significantly. Currently, the best first step in introducing wide-area networking may be to establish a reliable Local Area Network (LAN) with computers in classrooms. The computers, connections and the networking software used in forming a LAN vary considerably. Generally the LAN should support printer sharing, electronic mail, access to a central server and be capable of exchanging files at a rate of at least 10 million bits per second.

There are several advantages in establishing a school-wide LAN before introducing wide-area networking services. A LAN is a good platform for familiarizing users with the computers, network services and the training provided by local networking administrator. If the local support is not sufficient to maintain a reliable LAN, it will not support extensive use of wide-area services. After establishing a reliable LAN, you can attach a network "bridge" to allow all users on the LAN to access to wide-area network services.

Wide-Area Network Services

Many of the regional networks, that center on universities, government, and large businesses, are now connected to form the Internet (the precursor to the proposed higher speed NREN). Users of the Internet can exchange mail, make use of the higher processing capabilities of super computers and access resources servers across the Internet. The number of servers on the Internet is growing exponentially. These servers allow users to gain access to any information represented in a digital format including: text of newspapers and online journals, instructional software, terrain maps based on satellite imagery, and more recently, full motion digital video that is compressed in digital formats such as QuickTime™. Some of the fastest growing servers are those that adopt the file transfer protocol developed by The University of

Minnesota's "Gopher©" group, another file transfer system developed at Dartmouth called "Fetch©" and the text searching system for accessing information from the DowQuest™ developed by Thinking Machines Corporation called "WAIStation©." Because some of these developers openly encourage other to establish additional servers that use their protocol, the number of servers and thus the overall amount of information available through the Internet is likely to continue to grow at an exponential rate.

The standard for routing information on the Internet is the Transmission Control Protocol/Internet Protocol (TCPIP). Each computer using TCPIP must have a unique IP number for routing information requested from servers back to that computer. Thus, to connect a LAN to the Internet the school's network administrator will need to acquire a network bridge, a high speed data line to the Internet (preferably one that transmits at least 56 thousand bits peer second -- 56Kbps), and a series of unique IP numbers that anticipate growth across the school or district.

Designing Wide-Area Networks Interfaces for Teacher Education

Even with the vast amount information available through wide-area networks, it will be important that teachers and teacher educators immediately recognize the usefulness of available resources. Teachers need a navigational aid that assists them in integrating resources into their curricula. The resource navigation component of UNITE (Figure 1) serves this purpose through a framework for accessing and contributing to the catalogs of dynamic resources. Currently, the navigator has 16 content hierarchies (Language Arts, Math, Science...), with several hierarchies having over 100 sub-categories. Each content hierarchy is further expanded by cross-referencing with the primary support categories of administration, courseware, research and teaching. The navigator's links to instructional support are shown as icons representing the resource catalogs for: Field Trips, Lesson Plans, Courseware Descriptions and Research Abstracts.

Besides assisting teachers in integrating resources, we assumed that the resource navigation system must be easy for teachers to use. Others have noted the need for developing intuitive intefaces in public school computing networks (Bull et. al., 1993). However, a design that one group of educators finds intuitive may be difficult for another group. For this reason, we adopted a rapid prototyping (Tripp & Bichelmeyer, 1990, Carrol, 1990) approach to development that involved educators from several constituencies in evaluating designs (Aust & Klayder, 1991).

The current design emerged over a two year period and included five version upgrades. After each version release, users sent recommendations to the "Catalog Critics" special interest group on the electronic mail system. As the users worked with each prototype they began to comment on design issues and common preferences soon emerged. User recommendations resulted in changes to the icon design and placement, consistency, feature names and a general simplification of the interface. Without this rapid prototyping approach the design of the resource navigator would have been considerably different and likely less useful to educators.

The recently developed navigation systems by the Gopher© (Figure 2) and Fetch© (Figure 3) groups also provide insights for developing effective wide-area network navigation systems. Gopher and Fetch are both more open development environments than the UNITE resource navigator. They allow the server's systems operator to establish the content hierarchy those best suits local needs. Clearly, this strategy has been successful in terms of causing a proliferation of servers across the Internet. However, as the number of open content hierarchy servers expands, the number of "wayfinding" problems that cause users to become lost in hyperspace will likely increase as well (Kerr, 1986; Kinzie et. al., 1990).

A standard for organizing teacher education resources on wide-are networks is needed. The content structure of this standard should accommodate a variety of curricula so that teachers will easily understand how the resources are integrated with their existing teaching strategies. Other categories to consider for this standard include: media format, length, appropriate grade level, prerequisite skills, geographic stipulators, publisher, and support categories such as classroom use or professional development.

Community Published Dynamic Resources

The UNITE catalogs of instructional resources are dynamic because any user on the system can expand or modify them through a contribution and review process. Each catalog is essentially a distinct data-base consisting of tailored fields such as subject descriptor, grade level, equipment requirements and publisher. These catalog fields provide necessary indexing information for conducting multiple key word searches. In some cases, resource described in the catalogs can be previewed directly. For example, after reading a description in the courseware catalog, users can immediately preview instructional shareware packages.

The development of the dynamic resources follows recommendations for teacher collaboration and empowerment (Goodlad, 1990; Grady, 1988; McDonald, 1989; Maeroff, 1988). Instead of imposing top-down "expertise," contribution tools encourage educators from all constituencies to participate in both contributing and reviewing resources. Any user can contribute a suggestion by first selecting the "Add a New Resource" or the "Modify an Existing Resource" option. Users follow a step-by-step procedure as they are guided through the contribution process. When a contribution arrives at the hub, a message is sent to all reviewers explaining that a resource is available for review. Reviewers are extended throughout the system and may include representatives from all constituencies.

Once a resource is requested by a reviewer, it is unavailable to other reviewers until released. This avoids conflicting reviews. During the review process the reviewer and author often communicate through electronic mail to exchange suggestions or resolve concerns. Once approved, a new or modified resource becomes available across the network for use and/or further modification. Names of the original author and reviewer as well as the names of any other contributors or reviewers are listed with each resource entry.

An evaluation of resource usage patterns and observations of UNITE users revealed several insights concerning the use of computer based resources by educators. First, many users expect vast amounts of information under each resource category and if their favorite category is low in resources they lose interest quickly. Also, different constituencies prefer different resource categories. For example, teacher education majors prefer catalogs of lesson plans whereas practicing teachers prefer resources of a timely nature or regional specialty. Some of the most often used and best received resources are those developed for local use, such as data bases of field trips. Searching mechanism for large scale database should include indexes (e.g., by county) for tailoring searches to regional interests.

Regarding community publishing, users who publish on networks become vested and are more likely to continue network use. In a vote during one UNITE project, teachers unanimously preferred a peer review, as opposed to an administrator controlled, process for monitoring publication on the system. We also found that the teacher education constituency most likely to freely contribute resources are teacher education students. Most teachers, on the other hand, will expect some form of compensation for contributing resource entries. This compensation may be in the form of monetary reward, release time, course credit or additional access to networking resources.

Social and Administrative Considerations

Many of the initial social and administrative barriers to electronic networks may be overcome by providing direct and immediate access for all teachers. After conducting a naturalistic study (Guba, 1981) on the implementation of UNITE, Bichelmeyer (1992) concluded that the integration of technology in schools is often constrained by a Teacher Needs Hierarchy. This hierarchy's contingency schedule is similar to Maslow's Human Needs Hierarchy where level one must be reached before level two is reached and so on. She proposed the following steps in the Teacher Needs Hierarchy: (1) Time and Accessibility, (2) Dependability, (3) Vesting, (4) Control, (5) Integration.

As Cuban (1986) documented, the initial enthusiasm for technological innovation often subsides rapidly if measures are not taken to manage expectations and renew interests. Much of the local enthusiasm is often associated with individual advocates whose status or popularity influences success. When these individuals leave a site the enthusiasm for "their" innovation often leaves with them. This is especially true when incoming technology mentors seek to make their mark by adopting and advocacy that differs from the predecessor. Advocates should attempt to extend enthusiasm so that all participants have ownership in the innovation -- an approach that may require significant restructuring of school's reward system.

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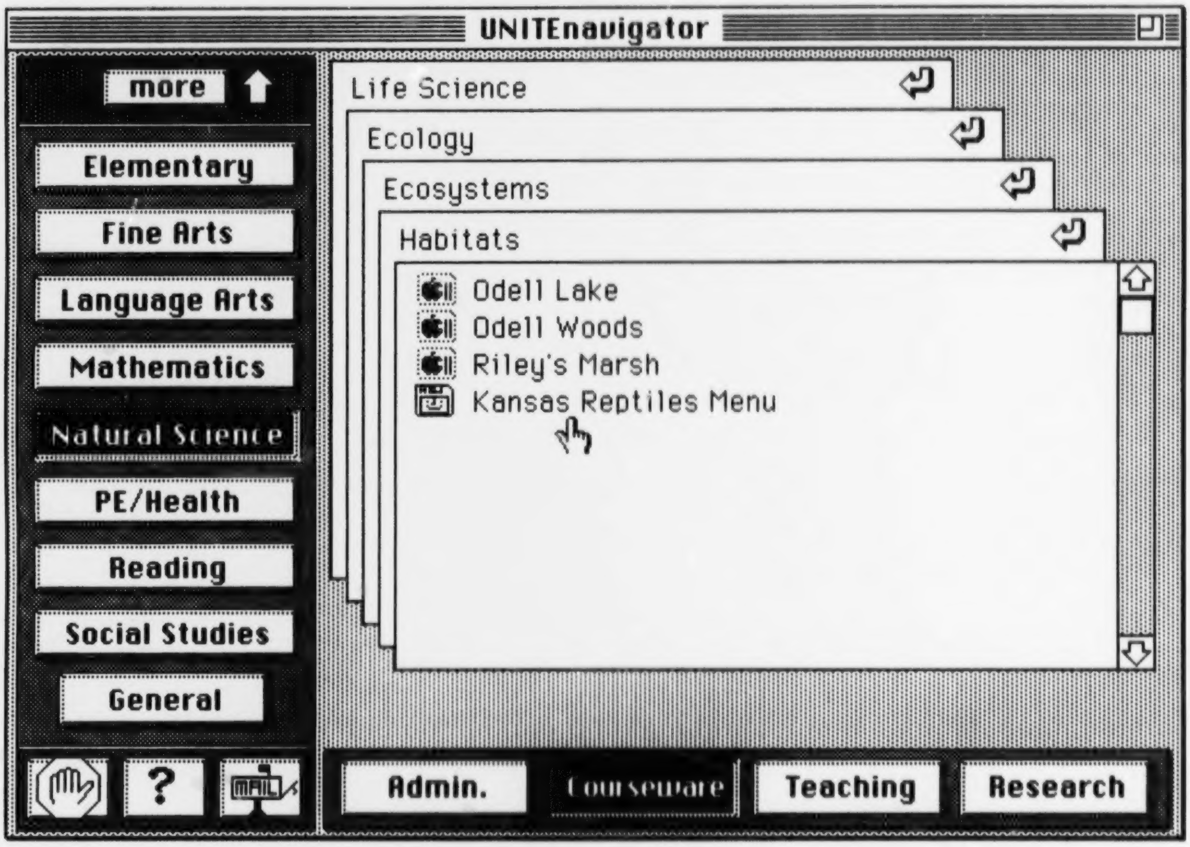
Tripp S. D. & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. *Educational Technology Research and Development, 38*(1), 31-44.

Figure 1

The UNITE Resource Navigator

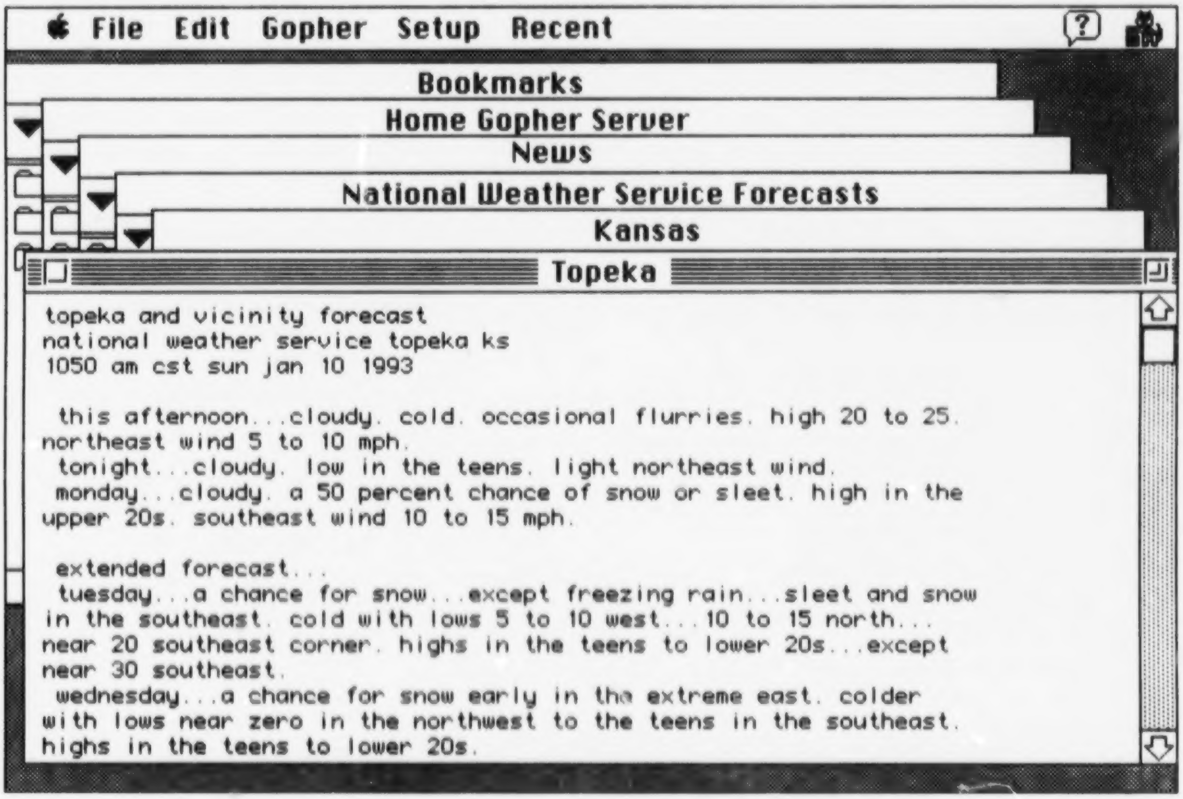

UNITEnavigator
more
Elementary
Fine Arts
Language Arts
Mathematics
Natural Science
PE/Health
Reading
Social Studies
General
?
MAIL
Life Science
Ecology
Ecosystems
Habitats
Odell Lake
Odell Woods
Riley's Marsh
Kansas Reptiles Menu
Admin.
Courseware
Teaching
Research

Content categories appear vertically along the left margin of the screen. The four support categories, Administration, Courseware, Teaching and Research appear horizontally along the bottom of the resource navigator. In this view the user began by selecting the support category for Courseware followed by the main content category Natural Science and then the sub-categories of Life Science, Ecology, Ecosystems and Habitats.

In this view the user is about to selected the software *Kansas Reptiles Menu* listed under the Courseware support for the selected content hierarchy. The dark icon in front of the listing indicates that the user will be able to directly preview this software on the UNITE system.

Figure 2

The Gopher© Navigational Interface



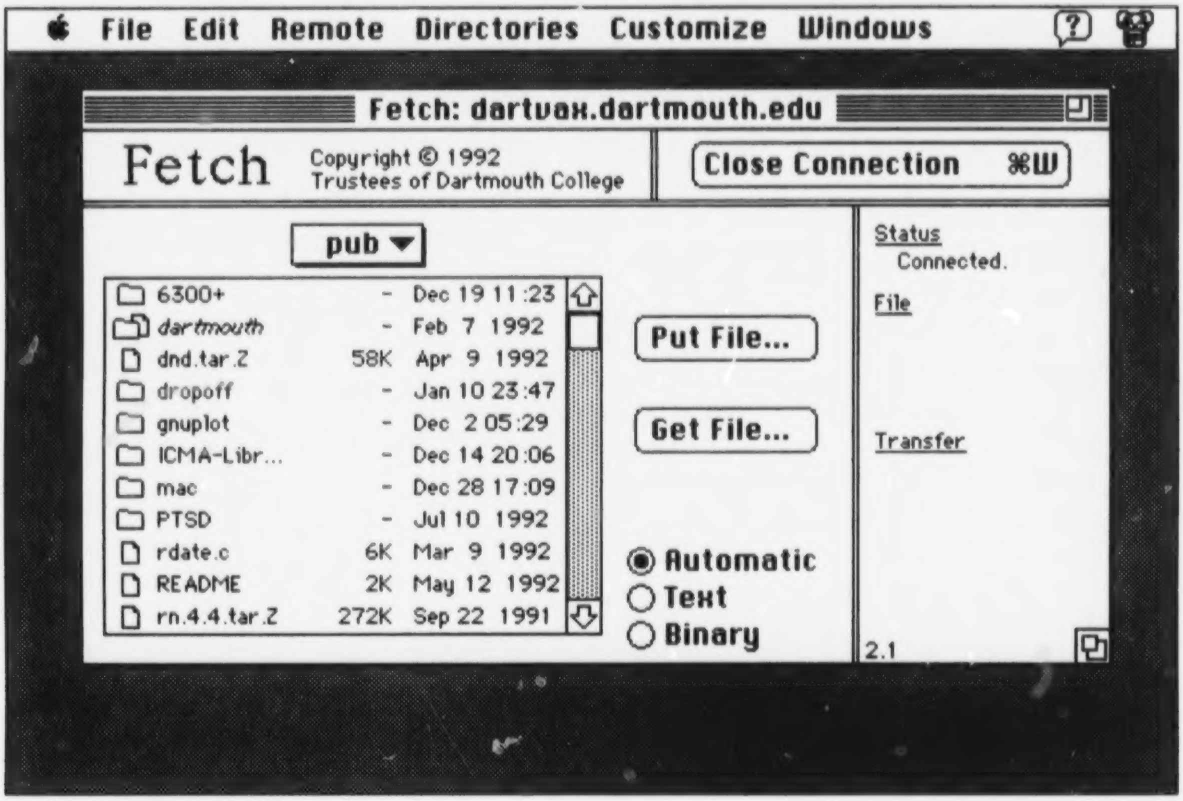
```
topeka and vicinity forecast
national weather service topeka ks
1050 am cst sun jan 10 1993

 this afternoon...cloudy. cold. occasional flurries. high 20 to 25.
northeast wind 5 to 10 mph.
 tonight...cloudy. low in the teens. light northeast wind.
 monday...cloudy. a 50 percent chance of snow or sleet. high in the
upper 20s. southeast wind 10 to 15 mph.

 extended forecast...
 tuesday...a chance for snow...except freezing rain...sleet and snow
in the southeast. cold with lows 5 to 10 west...10 to 15 north...
near 20 southeast corner. highs in the teens to lower 20s...except
near 30 southeast.
 wednesday...a chance for snow early in the extreme east. colder
with lows near zero in the northwest to the teens in the southeast.
highs in the teens to lower 20s.
```

The Gopher© software and protocol were designed by the Gopher team at the University of Minnesota. Gopher is a fast and simple way for searching and distributing files that has gained considerable popularity on the Internet. Each server administrator determines the structure of the content hierarchy on their server. Gopher databases usually use full-text indexes meaning any word in the database is a key word.

In the above depiction the overlapping windows show the path the user took to obtain a regional weather report from the national weather service on the home Gopher server. The National Weather Service data base is updated frequently.

Figure 3

The Fetch© Navigational Interface


File
Edit
Remote
Directories
Customize
Windows
Fetch: dartvax.dartmouth.edu
Fetch
Copyright © 1992
Trustees of Dartmouth College
Close Connection ⌘W
pub
Put File...
Get File...
Status
File
Transfer
2.1

6300+	-	Dec 19 11:23
dartmouth	-	Feb 7 1992
dnd.tar.Z	58K	Apr 9 1992
dropoff	-	Jan 10 23:47
gnuplot	-	Dec 2 05:29
ICMA-Libr...	-	Dec 14 20:06
mac	-	Dec 28 17:09
PTSD	-	Jul 10 1992
rdate.c	6K	Mar 9 1992
README	2K	May 12 1992
rn.4.4.tar.Z	272K	Sep 22 1991

● Automatic
○ Text
○ Binary

Status
Connected.

The Fetch© system was developed at Dartmouth College. Fetch uses the File Transfer Protocol (FTP) to transfer files on the Internet. The interface is similar to the one used by application programs to locate files on a hard drive.

Title:

Promoting Success in Educational Partnerships Involving Technology

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Background

Schools have always received some measure of community support, such as parental assistance, volunteer efforts, donations of money and equipment and provision of needed expertise. But fueled by reports such as a Nation at Risk, calls for school reform by almost every major political candidate and ceaseless media accounts of apparent educational failure, there is a growing public perception that American schools are in a crisis professional educators can't fix by themselves. One positive result of this perception is more organized and substantial involvement in schools by influential community institutions, which band together in "educational partnerships" to provide resources and services.

Such educational partnerships are increasing dramatically. There are thousands of them, big and small, and more all the time; the National Alliance of Business (NAB) estimated 140,000 in 1985. As might be expected with a growing phenomenon, these partnerships are as diverse in their purposes as they are in their membership. Small collaborations, such as those between a single local school and a neighborhood business, are usually focused on providing a particular service for a specific school group, such as business mentors for science students or tutors for at-risk kids, or they may provide in-kind assistance such as free printing of school materials. They may also donate items to the school. Larger partnerships, involving bigger businesses or corporations, and/or universities and groups of schools, usually have more ambitious and far-ranging goals, including effecting comprehensive school reform.

For many reasons, the goals of these larger educational partnerships often include the purchase of educational technology and promotion of its integration into the daily life of schools. Educational technology is new and exciting, has a high public profile and is often cited in popular and professional literature as a catalyst for major changes in teaching and learning. At the same time, however, technology can be expensive and adopting it can be complex, so that even if it is thought desirable, the purchase and effective use of educational technology may tax the means and experience of individual schools or school districts. It is therefore likely that professionals in businesses, universities and schools interested in educational technology will find themselves reaching out to and working with other community groups to make possible together what might not be possible alone.

For those contemplating such collaborations and those currently involved in one, it would be helpful to know the experiences of others. A description of what has worked in educational technology partnerships from the point of view of those who have been involved with one should therefore be very useful.

Yet unfortunately, while quite a bit has been written about educational partnerships in general, not very much of it has been specific to technology. This is true whether you examine the business, educational or technology management literature.

The older business literature tends to focus on the perception that schools are doing an inadequate job preparing the future workforce as a rationale for business initiating involvement in education through partnerships. More recent analyses often reflect a clear-eyed reassessment of the efficacy of partnership arrangements, frequently citing corporate frustration with slow or superficial change and a lack of "accountability" for resources used. (see Chion-Kennedy, Edelstein, Mann, Rist) Both the early and the recent analyses sometimes refer in passing to a lack of technical sophistication among today's students but they generally don't single out technology or technology partnerships for special notice.

Educational analysts largely divide into two camps, those who consider partnerships as one more form of school change initiative and those who consider them as policy-making bodies. Like business observers, school change writers do not distinguish technology partnerships from other collaborations. Instead these writers point to the difficulty of effecting comprehensive and lasting change regardless of the innovation. (See Fullan, Lieberman and Miller, Sarason, Senge, Sirotnik). An exception here is the work of Larry Cuban, who focuses on the failure of teachers to adopt educational technology in significant ways (see Cuban). However, Cuban does not speak to partnerships.

Educational policy analyses consistently emphasize that no matter who does it, educational policy-making is largely political, as the process of determining "who gets what, when and how" is essentially a process of exercising power and influence no matter what the reasons or who the involved parties. (see Campbell and Mazzoni, Easton, Lasswell, Pawley). This literature is just beginning to speak to partnerships as policy-making bodies and so does not separately consider technology partnerships.

Last, the technology management literature has a substantial group of analyses concerned with both technology and partnerships. But these studies are largely focused on examining the efficacy of university/corporate research and development collaborations and their success in developing and promoting commercially-viable and competitive technologies. (see Fassin, McBrierty and O'Neill, and Phillips). The findings of these studies might be relative to educational partnerships, at least where universities are involved with schools, but that connection has not yet been directly drawn.

To summarize, while it would be beneficial for professionals in business, universities and schools who might work together to know what factors help lead to success in educational partnerships involving technology, not much research has yet been done which is specifically helpful.

Research Questions

The major research question for this then study is:

What are the common features of successful technology partnerships?

Related research questions are:

How is success defined and measured?
Which features are identified as successful most often?
Which features are identified as problematic most often?
Does the nature of the group involved (i.e., business, school, university) make a difference in which features are identified as successful or problematic?
What suggestions for success are made by partnership participants?

The wording of these questions indicates an emphasis on identifying factors which contribute to the success of technology partnerships from the point of view of those currently involved in one. The intent of these questions is therefore descriptive and pragmatic rather than conceptual or theoretic. It is hoped answers to these questions will be of practical help to professional people contemplating or involved in partnerships. It is only just now that many partnerships are of sufficient duration that their participants can assess their progress and draw conclusions to share with others, so answers to these questions should prove timely and helpful.

Method

Preliminary analysis was done on a pool of professional literature, journal articles, grant reports and other assessment documents of educational partnerships. The pool resulted from a comprehensive review of education, business and technology management literature, and published Department of Education (DOE) grant reports. (SeeDanzberger for example) These articles, grants and reports were examined closely to see what features of partnerships they identified as helpful or problematic and what suggestions they made for improvement.

The results of this preliminary analysis pointed to the following elements as contributing to success: shared vision; clearly-defined goals; an institutionalized decision-making structure; local decision-making; continuity among partnership personnel; allowing sufficient time for change to occur; and provision of professional development time and training to teachers. This analysis also suggested that as outside policy-making bodies often charged with allocating much-needed resources and composed of people from disparate institutions with different standards, operating procedures and goals, ("culture"), partnerships hold the potential for much conflict. (See Sirotnik for example)

However, these preliminary results had some limitations. First, materials specific to technology partnerships were limited. Second, the reports and articles which were available were universally positive in tone and far more likely to identify successful features than problematic ones, probably reflecting a natural tendency to play up successes when reporting publicly on a project. Yet it could be as helpful for others to know what didn't work as what did. Third, the documents examined often didn't distinguish the disparate views of particular participants. Instead they were consensual, making it impossible to determine if, for example, the business partner disagreed with the school partner on what was successful and why. Last, because there were not very many summary articles and reports readily available, few were the results of systematic, formal research into partnerships, and identification of features which lead to success was not a major emphasis of much of what was written, the preliminary analysis was based on a relatively small amount of data. For these reasons a second method was used to elicit more complete information.

Additional data was collected nationally by a 45-minute, open-ended telephone interview with 23 representatives of 15 educational partnerships. Each had at least two years' experience with a partnership, collaboration or consortium of some complexity, involving at least two parties and administration of a large federal grant specifically focused on educational technology. (DOE FIRST [Fund for the Improvement and Reform of Schools and Teaching] grants, with an average award of $117,214 per year for two or three years.) For most of the respondents 1992 marks the final year of a three year grant which began in 1989. For some, the grant ended last year or this past summer, so each has completed or is completing their project. Many had written or contributed to one or more assessment reports as part of their grant reporting requirements, and so had the experience judging the success of their projects.

All 23 respondents were somehow involved with managing the federal grant and/or the partnership related to it, being the ones empowered by their institutions to make decisions and allocate resources for shared partnership activities. Five people were school district representatives of some kind, five represented corporations, eleven were from universities and two were from state or regional education departments or centers.

Results of the preliminary analysis were used along with the study research questions to guide design of the interview questionnaire, which solicited comments on how each partnership organized collaborative work, how the representative felt about being part of a partnership, how the partnership evaluated success and what features aided or impeded success. Respondents were also asked to state their advice to people beginning partnerships. (see Appendix for interview protocol)

Statements in response to the questionnaire were examined for similarities and then grouped into categories to make dominant patterns apparent. These patterns are discussed in the results section below, presented along with some individual statements which were not widely replicated but appear nonetheless interesting or insightful.

Results

There is little question that professionals from all three groups, universities, businesses and schools or school organizations, generally enjoyed being part of a partnership. Many respondents described their participation as "stimulating", "challenging" and even "fun", presenting a definite "change" from their usual activities which afforded them "opportunities" for both personal and professional growth. Most also felt greatly rewarded by their contact with a new set of "colleagues", whom they often described as "friends" as well as "innovative", "creative" and "exciting" peers.

About a third of the respondents saw the partnership as a means to expand their range of personal "connections" and "professional opportunities". A third also appreciated their chance to be involved in a "real" project and watch the educational process unfold from an "insider's view" rather than from a distance as an outside professional observer or lay citizen. And almost half found pride and gratification that they had been part of something which "made a difference", elicited "good feedback" or had an "impact" on education. (Categories are not mutually exclusive. Respondents could give two or more answers to a single question and so be counted in more than one category).

Respondents also liked being part of a partnership for the unique benefits they felt collaboration brought, including much-needed "money and other resources", the "synergy" afforded by sharing "information", "ideas" and "purposes" and the "new perspectives" brought to educational problems and circumstances when multiple people from disparate backgrounds interact.

In addition, over half the respondents signaled their intent to continue the partnership in some way after the initial three-year grant period ends and federal monies disappear. Some of these were writing other grants for support, while others planned to absorb ongoing costs among involved institutions. Of the 11 respondents who said "no" or "maybe" to continuing their partnerships, none said they would never participate in another partnership and most were actively soliciting new partners for new purposes. The general consensus on participating in partnerships appears to be, as two respondents put it, "Go for it!"

Measuring Success

However, because participants generally enjoyed being part of a partnership does not mean their partnerships were successful, so **how did partners define and measure success?** This question is particularly important in light of the preliminary analysis, which suggested that both differences in institutional cultures, which affect what kinds of results are valued, typical reward structures and standard operating procedures, and differing institutional agendas for participating in partnerships can cause serious disagreements about what constitutes success and how to recognize when it is reached.

In this group, only two respondents were not sure if their project had been successful overall, one citing that she was too "close to it to tell objectively", and the other that he regretted "they could only go so far since it was important not to go too fast." The 21 others described their projects variously in laudatory terms such as "a model others can use", "110% effective" or "it reinforced our initial beliefs."

15 of the respondents stated that their projects used specific concrete products to gauge success, including improvement in student test scores, production of curriculum units and lesson plans, development of multi-media protoypes or educational software, and measurements of technology usage, such as hours spent in computer labs, or cost of on-line connect time. The others used either accomplishment of grant goals, such as attainment of "objectives" or "outcomes" or adherence to "benchmarks" and "timelines", or qualitative measures of student and/or teacher attitudes and behavior, such as "comments",

"feedback" and "evaluations", as measures of accomplishment. Many had a mix of ways to gauge their success, including formal evaluation by paid, outside evaluators, often university staff.

Even though the majority of respondents felt their project was successful overall, they nonetheless expressed reservations about how evaluation was done, 6 persons saying they either didn't agree with the methods used to gauge the success of their projects or weren't sure of their effectiveness, and many of the 17 others agreeing overall with the methods used but with some specific concerns. These concerns were divided about equally between those who wished more traditionally rigorous, quantitative assessments of progress and those who thought qualitative measures more appropriate. Comments indicating a desire for more rigor included "need more evaluation at the school level-- it was hard to document what the teachers were doing", "there was no control group", "I'd prefer more concrete benchmarks", and "there were little pre- and post-test differences", while those arguing for more qualitative measures stated "it's hard to measure long-term goals", "I'd prefer to judge investment in people, not scores", "traditional evaluation took too much time for the results gained", "I'd add qualitative measures of attitudes or the energizing effect of collaboration", and "usual methods are merely 'add-ons' at end of the project, but no one will give you grant money for formative evaluation."

The concerns expressed about the effectiveness of evaluation in this group suggest that measuring success is one of the more problematic aspects of a partnership. While on the one hand partners are convinced they have been largely successful, on the other hand they are not satisfied with how that is proved. Their measures of success often appear to be at odds with their perceptions of success. This may be because participants feel torn between their generally positive inside experience of collaboration and the need to justify its fruits to influential outsiders, such as grant officers, tenure committees or school district administrators, in terms they can accept. Or it could be that differing cultural expectations of partnership institutions do mean differing perceptions of measuring success. Or it could be something else altogether. This study does not sufficiently address **why** these differences occur, but only points out that they do, just as the preliminary analysis suggested they might, which is something those contemplating a partnership should consider for frank discussion and negotiation among partners when deciding how to evaluate their projects.

Problematic Features

What features of the partnership were identified as problematic most often? Answers to this research question came from three sources, the responses to questions about what partnership features impeded success, what partners didn't like about being in a partnership and what things partners disagreed about.

Failures of planning and implementation

Failures of planning were mentioned most often as impeding success, including picking project "school districts too far apart geographically", having a "too fast production schedule" or a "contract too binding", "contradictions in project goals", "too much money spent on hardware with none for training" and "not designing technology centrally enough into the project".

It is relatively easy to recognize failures of planning after the fact when what hasn't worked becomes apparent. It is much harder to anticipate problems as you are beginning a project, especially when technology partnerships are a relatively new phenomenon, local conditions vary dramatically and there are few established guideposts to follow. As one respondent said, "This is an experiment, and we are learning as we go along." The simplest conclusion to be drawn from these experiences then, is to devote as much time as possible to planning, trying to anticipate problems, for "the more you plan, the easier it is to implement". But recognize there will be many problems which cannot be anticipated or controlled.

Planning problems were followed in importance by implementation problems such as excessive "changes in personnel", and introducing the project on too grand a scale with "the 'big pitch' which scared school participants".

Some of these barriers to success can't be anticipated or well controlled either, such as excessive turnover in personnel, which was also mentioned prominently among things respondents didn't like about being part of a partnership. When people change, it takes time to "know the new ones", or "bring them up to speed", and when key people go, they sometimes "take the commitment of their institutions and their resources with them". Yet while participants can discourage each other from leaving partnerships, they can't prevent each other from going, particularly since participation in the partnership is seldom anyone's main job, and most need to meet the demands of their primary job first. Personal and institutional agendas change through time, and preservation of the original membership in the partnership is rarely more important to participants than these other agendas.

Stress

In discussing what they didn't like, many of the respondents also decried the stress associated with belonging to a partnership, stress mostly linked to the amount of time and emotional energy that collaboration requires. Many partnership participants felt their institutions did not provide them with sufficient personal support for their positions, mentioning that they needed more "clerical help", more "staff" or "assistants", and most importantly, "time", particularly release time from their regular institutional duties. In a few cases, participation in a partnership was even added on top of someone's other job duties with no extra support at all, "I inherited it when someone else left."

One corporate officer and one university professor both felt they deserved a "promotion" for the work they'd put in but clearly didn't expect that their institutions would reward them that way for their participation. It appears partnerships are still viewed as peripheral commitments by many organizations, and their success relies quite a bit on the willingness of involved parties to go beyond what's provided out of personal commitment.

Logistical problems

On a more basic level, respondents also frequently mentioned persistent logistical problems which arose from the complexity of group managing a large project. These ranged from major decisions such as deciding who would "manage the money" or be "responsible to outside auditors", to minor but consistently annoying hassles over details such as "conflicting school and corporate calendars", "different business office procedures and techniques", and "free parking at the university". One university grant coordinator pointed out that her university was not used to producing anything but written materials, and so its procedures couldn't easily support her work with outside multi-media producers who required large amounts of cash and rapid production and payment schedules to do their work.

Respondents found that resolving these logistical challenges took a surprising amount of time, yet if left untended, could erupt into bad feelings. One school district technology coordinator laughingly referred to trying to park his car at the university to attend partnership meetings without getting a ticket he had to personally pay as a "constant thorn in his side" which, although minor, was a reminder to him that he was "not on my turf".

These differences in routine institutional procedures were surface manifestations of more profound instutitional differences which often caused considerable conflict. These differences surfaced in respondent answers about disagreement among partners. Only four of the 23 respondents reported no conflict of note, one explaining that disagreements varied by the people involved with "no major consistent" pattern, and another adding that their small working group made "agreement more possible than it would be among a large number of people". All of the others reported some disagreements.

In fact, the representatives of one project contacted declined to participate altogether because their collaborative work had proved so difficult the first several years that in the interest of remaining together in this better final year they didn't wish to "drag it all up again" by being interviewed. In addition, one multi-media production company was considering revising corporate policy to do educational media development entirely in-house rather than through partnerships with outside educational organizations because the "investment in time, money and energy" involved in collaborations was deemed too taxing for the return.

Disagreements between partners

The kind of disagreements most of the other respondents denoted varied by the organizations involved, as different concerns surfaced among partnership representatives than between representatives and teachers or representatives and technology vendors. Among partnership representatives three areas of disagreement were mentioned most often; allocation of resources, partnership roles, and pedagogy.

Representatives often had to choose among many competing uses for the money, technology and services their partnership had to provide schools. There were therefore hard choices to be made on who and what would be funded, what hardware and software would be chosen, and what direction staff time and energies would take. As one project director said, "We can think of 40 things to use the money for and can only do 3 or 4, so deciding what you're NOT going to do with resources is important... It was hard for us to say no."

Dissension also arose about what role each partner was to take in the project. Often it was not clear what each organization was expected to provide or each representative to do, and so representatives felt others were not doing their jobs or, as one project coordinator said, "holding up their part of the bargain."

This lead to resentment. In addition, as projects evolved, there was often a reevaluation of partnership roles, some partners becoming more active than others in different stages of the project. Agreeing on who should take an active role at any given time also caused dissension.

Last, partners did not always agree on pedagogy, which was clearest in discussions on the proposed content of educational materials, such as curricular units, lesson plans, computer programs purchased or developed for use in classrooms, and prototype educational CD-ROMs or videos. The director of research and development for a national professional association setting standards for the teaching of science pointed to the problem in his particular project. "There is a wide range of philosophical differences on how to teach science..the clash of ideas sometimes led to belittling and ridiculing of opposite positions."

In addition to these primary disagreements, as mentioned earlier, partners also disagreed to a lesser extent about the methods used to assess accomplishment of project goals, some wanting more "concrete benchmarks" than others, and about the project implementation process, particularly how to speed it up.

Disagreements about technology

Because these partnerships all involved educational technology, respondents singled out one kind of disagreement among partners for special mention. A little over a fourth of the disagreements mentioned were between other partners and the technology vendor in partnerships which had major hardware and software companies as members. Three kinds of problems were mentioned most frequently-- slow delivery of promised goods (hardware and software), unavailability of proffered training, and serious contention about the content of materials being collaboratively developed. In the first two cases, other partners felt the service by the technology partner "after the sale" was not as anticipated, either because the vendor primarily viewed the partnership as a chance to sell products and services rather than a true collaboration or because, although well-intentioned, many vendors were either too busy to guarantee delivery schedules and training as planned, or were too large and bureaucratic to secure the commitment of corporate headquarters to partnership activities. The principal investigator on one grant said, "Over time we got more (goods and training), but I'm not sure we got more than usual people who buy hardware. Corporate headquarters of company "A" wouldn't commit and company "B" is always reorganizing, so it was too little, too late on gear and training."

The problem over developing materials collaboratively is a good indication of how different organizational cultures can cause conflict. In two cases serious differences arose between the educational partners and the media production staff of the technology partner over the content of educational materials produced. Naturally enough, the educational staff placed primary emphasis on the teaching and learning objectives of whatever was being produced and the media producers were primarily interested in its interest level to students. One grant principal investigator said working with a scriptwriter epitomized this conflict in approach. "It was hard to get him to realize our ideas. We had instructional design goals, he had entertainment goals. It was a knock-down-drag out to build both into the script. The differences between us were very stark...clear differences in conception which were hard to blend."

Two respondents also mentioned "battles" between hardware and software suppliers trying to make their various technologies compatible in ways that would serve partnership goals. Project managers felt caught in between two competing interests, unable to coordinate efforts to go forward.

Disagreements between partners and teachers

Two major kinds of disagreements arose between partnership representatives and teachers. The problem mentioned most often was competing ideas over the amount and content of training offered. Teachers often preferred elementary training in how to operate a computer and use basic application software, while partnership representatives were emphasizing classes in integration of the computer into classroom activities and development of original educational materials. One school district technology coordinator described this as, "We were determined to integrate technology and the teachers were determined not to."

The other primary disagreement was over assessment and evaluation methods. Project managers were often required by their grant to regularly evaluate progress and sometimes had concerns about teacher performance, so they were interested in timely and telling evaluations. Teachers, on the other hand, found some evaluation procedures intrusive or overly time-consuming and tedious.

To summarize, all but four of the partnership participants questioned were able to describe disagreements among partners. The nature of the disagreements varied by who was interacting, but there was dissension across a broad range of people and activities, including about the most fundamental work of the partnerships such as allocating money, assigning roles, choosing among educational alternatives, providing goods and services, training staff and evaluating progress. This pattern suggests that partnerships do not escape the conflict which the preliminary analysis suggested characterizes other educational policymaking bodies. Responses also suggest that the addition of technology into a partnership introduces a level of complexity which can present unique challenges.

Conflict resolution

Because disagreements can present major obstacles to success, it is also helpful to know how partners tried to resolve conflict and whether the methods they chose were successful. It's interesting to note, then, that regardless of their position or the kind of conflict they were discussing, respondents overwhelmingly described their primary method of resolving conflict as building "consensus" by "talking it out".

Consensus

Each described a process of dispute resolution which began with asking for alternatives, describing the advantages and disadvantages of each suggestion from each partner's point of view, and then choosing one alternative through "negotiation" and "compromise". Many mentioned they thought this process represented the essence of collaboration-- group decision-making through discussion and negotiation. One corporate education representative characterized it as "looking for a compromise. Seeing how we can change so that everybody enjoys a winner..a good partnership will give everybody something to win about." Others described it as reaching a "common understanding" or "tandem decision-making".

Most recognized, however, some limits to this method of resolving conflicts. First, it can take a long time, as one project director noted, "Collaborative work has its own timeline. It is much slower than when telling them (others) what to do. That isn't bad...it's just a different pace which takes adapting to."

In addition, many responses pointed to a set of attitudes which must be present for this kind of conflict resolution to work. People must trust each other, know each other's working style, and be willing to critically examine and change their own opinions and occasionally, behavior. The same person continued, "You must be willing to work as much on the relationship between people as on tasks. That was a personal learning for me as a project director. You must be open to change and be a co-learner." Another project coordinator felt facilitating group process was the most challenging part of her project, indicating that most adults, even teachers, have no formal training in collaboration and do not automatically know how to solve problems and make decisions together. The needed attitudes and actions were therefore learned, sometimes painfully, in the process of working together.

Role of the project coordinator/manager

Many of the responses outlined a critical role in the dispute resolution process for the project director or coordinator, those partnership managers who are responsible for the day-to-day operation of the project. One said she would only hire project coordinators like theirs who had "experience running complex projects and getting people to work together". Another said a crucial part of her role as project coordinator was to do the "summing up" at the end of meetings which helped people choose among alternatives.

In addition, if people were not able to reach consensus, which many said happened occasionally, the project coordinator or director often made a final determination, sometimes by "delaying a decision until a better time arose", or "dropping one idea and substituting another" or even by "taking the project and running with it", i.e.. making the decision he or she thought best for the project. When this last happened, the coordinator or director usually justified the decision to the others by reference to the original purposes of the project as represented in project documents or by citing grant demands made by the government funding agency. Respondents clearly linked group decision-making to the idea of a partnership, and felt it "heavy-handed" when either they, or someone else in the partnership, made decisions unilaterally. As one said, "It takes longer to make decisions together but telling people what to do doesn't work, so it works out better this way in the long run."

In three of the 23 cases this process of consensus didn't work at all. Two of these cases involved school districts and hardware or software companies, and one concerned a school district and a group of teachers. In the first cases, the school district partners found the vendors to be uninterested in true collaboration. They claimed corporations either disappeared after the sale of hardware, providing little further support, or overly limited school district participation in joint activities with tightly worded partnership agreements. In one partnership between a school district and a multi-media development company, a contract outlining the duties and obligations of each partner was considered too restrictive by the school district representative, who felt left out of decision-making about the educational content of the product. Yet the same contract was considered routine by the corporate representative, used to the highly competitive software industry in which protection of corporate creative processes is paramount in any collaborative work.

This misunderstanding points to a clear difference of organizational culture as reflected in the documents and standard operating procedures which embody organizational values. The corporate representative explained school district concerns as resulting from a scheduling problem. "It was not anyone's fault. It was just circumstances. There are differences in the way schools and corporations carry out their work day. We're in a production mode whether schools are in summer break or not, so if kids and teachers aren't around, I make do with other kids, other classes."

She added that the consensual process of solving conflicts such as this was different for her as a corporate partner. "Production and creative decisions are made by huge numbers of people bantering about ideas in a software company. It takes time, and feelings get hurt. I was relieved to work in a situation (in the schools) where people liked my ideas." She detailed a process in which she presented the partnership with production company ideas about the educational content of the medium being produced, followed by some discussion in which there was minimal objection on minor issues ("no red flags") after which she tried to "follow the consensus" in the subsequent production. She didn't feel she had to "fight for my ideas" as she would have done in a corporate environment.

However, the school district representative on the same project felt the district had only minimal impact on the educational content of the product. She cited contract provisions which would financially penalize the school district for making any changes which slowed down the production schedule which she felt inhibited her group from persisting in their pedagogical concerns. The corporate representative apparently did not realize her school district counterpart felt this strongly, as she thought there were no major disagreements on content.

False consensus

This points to a danger focused on by another of the respondents-- the problem of acceding to a false consensus. The desires to get along amicably, make deadlines and meet the goals of the project and demands of the funding agency can cause people to agree to what they think everyone else wants even if they or their organization feels what is being proposed is a bad idea-- a kind of "group think". The director of research and development responsible for one project referred to this as the "Abilene paradox" after the work of management professor Jerry Hall, saying "a lot of decisions are based on people agreeing because they think it is what the group wants, but no one wants it really." To avoid this false consensus, this director prefers open and pointed disagreement to acquiescence in the interest of collegiality or expedience.

'Exiting'

The unresolved conflict between teachers and the school district was over the content of training and demonstrates the success of the "exit" strategy in influencing group processes. School district partnership representatives, sensitive to the outlines of the grant underlying the partnership, wanted teachers to integrate technology into the classroom, bypassing or hurrying through the process of learning the basics of computing and common application programs like word processing. But teachers did not want integration classes and chose not to attend them, no matter how many were offered by the district, at what times and for what pay. They "exited"; a powerful ploy used by those not in power to frustrate the aims of those above them with whom they don't agree. This conflict was never resolved to the district's satisfaction, and this part of their project went unrealized as a result.

"Exiting" was also used as a strategy by partnership representatives in many of the other projects, even where consensus did work to solve most issues. At least five respondents mentioned partners who had withdrawn, usually the corporate partners, individual school districts or individual schools. Four others mentioned changes in personnel, moving partnership representatives around until they found a "stable working group" which could "deliver on what they promised." Indeed, as mentioned earlier, high turnover in personnel was cited in three cases as a major obstacle to accomplishment of project goals, as new people had to be "brought up to speed" before the partnership could proceed.

Four partnership representatives also mentioned threatening to exit, i.e.. stating their intent to withdraw partnership resources from school districts, schools or teachers who were not fulfilling their obligations. These "threats" were often first carefully stated in writing with follow-up telephone calls or site visits by project directors or coordinators. Usually such threats were effective. Where partners or participants withdrew it was of their own accord, few were "dropped" by the others.

In summary, most partnerships resolve conflicts by identifying and weighing alternatives and talking things through to a consensus, a time-consuming process of negotiation and compromise which partners recognize as requiring special skills in group process, and a willingness by partners to learn new things, be open, trust each other, and change positions.

In addition, project coordinators or directors, as the day-to-day managers of most technology partnerships, frequently have a special role to play in conflict resolution as the ones who make partners confront each other and the issues, who summarize positions so decisions can be made, and who take over decision-making when an impasse is reached. They are often the facilitators of conflict resolution and the guardians of group process. It is seen as part of their job by the others involved.

Also, where consensus fails to resolve disputes, the "exit" strategy is often used by partnership representatives, who either withdraw or threaten to withdraw their organizational resources from the partnership. Exiting can be represented formally by threats to retract manifested in documents, phone calls or visits, or informally by non-participation in meetings or activities, i.e., partners can leave or they can fade away. They are seldom booted out.

Last, beware of false consensus. The desire to please each other and forge ahead can lead people to agree to what they don't really like or think practicable, which can create problems when differing organizational cultures and standard operating procedures undermine underexamined goals.

What features are identified as successful most often? What advice do participants have for others beginning partnerships?

Answers to these research questions came from reponses to three questions on the questionnaire including, What features of their partnership lead to success?, What would you change if you could begin again? and What advice do you have for those beginning partnerships? Answers to the first and third of these questions overlapped significantly, so they will be discussed together below.

When respondents were asked what they would change about their partnerships if they could start over, 8 of 23, almost a third, said nothing. Half of these didn't identify any major problems in the course of their partnerships, and the other half didn't feel the problems they experienced were debilitating enough to warrant making any changes. Overall these representatives were fairly satisfied with the way things went.

Choose people and sites carefully

The other two-thirds would change their partnerships in a variety of ways, most frequently by including either different people or a wider range of people. Eleven references were made to being 'choosier' in who the partnership included. These were usually made by representatives of the initiating partner, the organization which first solicited other partners and drafted the grant proposal. These respondents felt the push to find sites and encourage participation sometimes brought people and organizations together without due consideration for their true willingness or ability to actively participate. Several representatives mentioned the importance of being able to pick who they worked with, whether that was someone in a partner organization with whom they "already had a working relationship", someone who could demonstrate their ability to "deliver what promised" or someone who chose to be included rather than being assigned by administrative staff.

Respondents would also be more selective in picking project sites, choosing fewer districts or schools, sites geographically closer to the project administration point, or those which represented "ideal conditions". Two even mentioned having some kind of competitive process for inclusion in the project. One project director who had worked with a large number of schools and districts over the three years of her project said, "I would be choosier...look for optimal conditions rather than anyone who wanted to work, and put conditions on schools to be selected. Have them put in writing what they will do to support us."

Eight references were made to including a wider range of people, usually to ensure critical support from interested "stakeholders", particularly principals. As the people primarily responsible for decision-making and allocation of resources in school buildings, principals are crucial to the success of any educational change effort, technology projects included. One project director said about administrative support for her teacher training project, "There should be some really. For the most part, they didn't support. There wasn't an administrator at the schools who knew and who cared. It made it hard for teachers to request individual support." One school district technology director who had helped choose sites for a project by mailing a survey to the schools added, "Now I'd go to individual schools and interview principals and technology teachers...I'd do more personal interfacing with principals. It was more important than I realized."

Some answers to Question 8, (Do you have any advice for those starting partnerships now which will help them be successful?) corroborated this emphasis on including all important stakeholders. Three references were made to soliciting comments from impacted groups during the grant writing and planning stages to secure their ideas and interest early, and others mentioned including everyone at all levels in every phase of the project (planning, implementation, evaluation) and securing organizational, rather than merely personal, buy-in. This last suggestion reflects the experience of projects where a critical person or persons exited during the project, taking their organizational commitment with them. Representatives who had experienced this problem suggested getting an institutional commitment in writing before the project begins. Others mentioned "keeping the original personnel if possible".

Technology

The remaining answers to the question about what partnership representatives would change were all specific to improving the technical aspects of the project, but there was no clear pattern to the responses. Instead each responded about the particulars of their own project. However, several mentioned an important point which was assumed, though not stated, in most responses--technical stability and reliability. In every project technology was seen as the means to a desired end, usually some improvement in teaching and learning, an end which could not be accomplished if the critical technology needed was absent, broken, unreliable or overly complex. Having dependable technology is critical to these kinds of projects.

The largest set of responses beyond this basic point involved improving teacher training, suggesting that training is viewed as critical to the success of many of the projects but can be hard to do effectively. Suggestions here were varied, including "begin with teachers beyond the basic learning level", "ask for one year to train", "use technology 'mentor' teachers for peer training", and "monitor the quality of in-service training".

Respondents also made a group of suggestions about production of educational materials, including "get a production staff with educational experience", "use existing materials rather than try to develop your own", "leave plenty of time for production", "teach the government [DOE] to be flexible in production schedules" and most interestingly, "be entrepreneurial...use the government seed money to form a partnership with a production house to develop educational materials and use the profits from the product to fund district technology needs and projects."

Have clear roles and expectations

When giving advice to those starting partnerships (Question 8) respondents overwhelmingly pointed to the necessity of outlining clear, specific roles and responsibilities for each partner which are stated in writing and agreed to before the project begins. Suggestions for inclusion in these kind of written agreements were a "few clear, simple and direct statements of project goals", a "formal team structure", "defined outcomes", and a timeline for accomplishment of project "benchmarks". The purposes of such written agreements were stated variously as to "make expectations clear", "assign responsibilities", allow for consideration of each partner's "real constraints", get to "know each other's strengths" and make sure the team is "moving in the same direction, not on individual agendas." One corporate education manager described it as setting up a "win/win situation" from the beginning, and advised re-negotiating the agreement every year to adapt it to current conditions, making it a "living document".

Cultivate collaborative skills

Another large group of advice responses centered on cultivating the personal characteristics that collaboration requires. Partnership representatives suggested involving or developing people who were flexible, open, creative, willing to "share ideas" and capable of working on a basis of trust and respect. They should also be daring, "willing to push the limits of what is possible" . In addition, four references were made to the need to be dedicated and hardworking, i.e., people for whom this is not just a job, but a passion. The primary reason for the latter suggestion is because of the huge amount of time collaborative partnership work requires, often far beyond what people feel they are paid for or what their institutions anticipated when assigning them.

Pay attention to group process

The last major group of suggestions for those starting partnerships had to do with group process and dynamics. Here the most frequent suggestion was to meet often and communicate regularly so that people feel included and know what's going on. Several representatives also mentioned picking a good project coordinator or director, someone who could prove a strong 'anchor' for the project. And others advised openly recognizing outside constraints on the group, such as limits on time, staff and resources, "systemic influences" such as school district politics, and the impact of cultural differences between organizing institutions. One school district technology coordinator said, "You must understand and accept the culture differences. If you don't, then there will be continual problems. For example, university people must get something publishable out of an experience-- but teachers couldn't care less about that. The need to publish has implications for how you spend time... this must be understood and acknowledged."

To summarize, the primary advice of this seasoned group of partnership representatives was to be specific and clear about the goals of the partnership and to clearly define in writing before the project begins what each partner will be expected to do to advance those goals. They also strongly recommended promotion of the personal values and characteristics which make collaboration easier-- qualities of flexibility, openness, trust and respect for others mixed with creativity, daring and dedication. Last, respondents thought it wise to pay attention to group process by meeting regularly, talking about things, relying on the guidance of a strong project coordinator or director, and acknowledging systemic limits on what can be accomplished.

Are there differences between partners in what features are seen as successful or problematic?

Answering this question for the group of respondents as a whole proved difficult, largely because corporations were underrepresented among those interviewed. (5 of 23 respondents). Where more than one person was interviewed from a project (8 of 23 cases), the responses of each were compared to each other to look for differences. Many of those differences have been discussed in earlier analysis. However, more definitive conclusions would be possible with a larger corporate sample.

It is interesting to note, however, why businesses are not more represented. Business partners were the hardest to find to interview, in many cases because either their personal, or their institutional, commitment was relatively short-term and they were no longer active, working members of the partnership. In the special case of technology vendors as partners, corporate involvement often ceased or was sharply curtailed shortly after the original purchase or donation of hardware and software. Businesses which had long-term, ongoing commitments to a partnership were rare, even though as one corporate education manager avowed, "it's the only way to be truly effective...roll up your sleeves and get involved in every aspect."

Implications

It is clear that partnerships are a growing phenomenon, part of the ever-increasing overlap between schools and other major community institutions, particularly businesses and universities. People who involve themselves in partnerships generally enjoy their participation, and have high hopes their collaboration will make education better, thereby profiting society generally.

These high hopes, however, can mean partners do not anticipate many of the problems which managing a complex project can bring, the conflict which can result when organizations of disparate nature try to work together, and the time and energy it can take to work it all out successfully. Partnerships are not the panacea to educational ills some have suggested. They are hard work-- **and** hard work usually **added to** the already busy lives of many of the professionals involved. This is all the more true with technology partnerships, which often add a whole level of complexity to already complicated situations.

Yet the needs partnerships rose to fill aren't likely to go away soon, and the trend in education, and perhaps society in general, is increasingly toward disparate groups of people finding ways to work together for their mutual benefit. One project coordinator summed it well, reacting with excitement to her role as a "bridge" between the research, corporate and education communities, a "link" which, even if temporary, greatly enriches the experience and understanding of everyone involved. This "bridging" role is still developing, and as such is fraught with peril for those involved, but it also brings the stimulation of challenge and possibility.

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Appendix I. Interview Protocol

Name of respondent: ____________________
Title of respondent: ____________________
Respondent contact numbers :
phone: ______________ e-mail: ____________
Project Title : ____

Name of Interviewer: ______________
Permission to quote?: yes ____
no ____

Descriptive Questions

1. **Who are the partners?**

a. Organizational Name: ________________________
Organizational Type: ____________________

b. Organizational Name: ________________________
Organizational Type: ____________________

c. Organizational Name: ________________________
Organizational Type: ____________________

d. Organizational Name: ________________________
Organizational Type: ____________________

2. **What role(s) was each partner originally designed to play?**

Organization a: ____

Organization b: ____

Organization c: ____

Organization d: ____

3. **Who initiated the partnership?**

Description of Partnership Operations

1. How does your project coordinate partnership activities?
a) Do you have regular meetings? yes__________ no________
If yes,
how often? ____
where? ____
who attends ?____
is there an agenda? yes __________ no __________
If yes, who sets the agenda?

If yes, how are items chosen for discussion?

If no, how is the discussion organized?

If no, (your partnership does NOT have formal meetings),
how do partners decide what needs doing and how to do it?

b) How else do partners coordinate their activities?
telephone?

correspondence? (notes, e-mail, letters, memos, fax etc.)

(probe) any other ways you can think of?

c) who makes most of the day-to-day project decisions?

why this person(s)?

Partnership Affect

1. What do you like about being part of a partnership or collaboration?

(probe) anything else you like?

2. What do you dislike about being part of a partnership/collaboration?

(probe) anything else you dislike?

3. when disageements about partnership activities arise, how are they resolved? (Give example?)

(probe) any other ways of resolving disagreements?

4. on which partnership activities are partners most likely to disagree?

(probe) any other disagreements you can think of?

Perceptions of Success

1. What was the original role of educational technology in the project?

2. How central was that role to the entire scope/activities of the project?

2. Has the role of technology changed as the project progressed? yes __________ no __________
If yes, how has it changed?

why did it change?

3. Do you feel the partnership has been successful in helping attain the project's technical goals?
yes ___ no ____

If yes, what features of the partnership helped technology succeed?

(probe) Any other ways the partnership helped support technical goals?

If no, what features of the partnership impeded success?

(probe) Any other aspects of the partnership which impeded success?

4. How does the partnership gauge success?

Are there concrete products? yes ______ no _______

If yes, what are they?

If no, how else is success gauged?

(probe) any other ways the partnership gauges success?

5. Do you personally agree with these ways of gauging success? yes _____ no _______
Why or why not?

5. If you could begin again , what would you change about the partnership?

(probe) is there anything else you would change?

6. Do you have any advice for people forming partnerships now that will help them be successful?

(probe) any other advice?

7. Would you predict the partnership will continue after the grant is continued? yes ______ no_____

If yes, where will the money come from?

Have you submitted other grants? yes _____ no _____

If no, why not?

7. Has your project been formally evaluated? yes ______ no _______
If yes, internally? ____________ externally?____________ both? ___________
Would you be willing to share those evaluations with us? yes ___________ no __________

8. Would you like a copy of the results of this survey when it is completed? yes _______ no ______
If yes, send to : ________________________
____
____
____

9. Do you have anything you'd like to add?

Title:

Using and Selecting Graphic Techniques to Acquire Structural Knowledge

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Using and Selecting Graphic Techniques to Acquire Structural Knowledge

Abstract

Structural knowledge, the knowledge of relationships between concepts in a content area, is essential for comprehension and problem solving. One method of assisting learner in acquiring structural knowledge is through the use of graphic techniques as learning strategies. Graphic techniques, such as networks, pattern notes, semantic maps and graphic organizers, are two-dimensional diagrams of conceptual relationships. In this paper the characteristics of graphic techniques are described, and the cognitive processes used to construct the diagrams are proposed. We propose a model for selecting between different graphic techniques based upon the cognitive processes elicited by the technique, and the learning outcomes derived from these processes.

Structural knowledge is knowledge that represents the relationships between concepts in a content domain. While structural knowledge may be conveyed in a number of ways, recently there has been an increased interest in techniques that display structural knowledge through graphic depictions of the relationships between concepts. This paper is based upon the premise that when different graphic techniques are used as learning tools different cognitive processes are elicited, resulting in different learning outcomes. The purpose of this paper is twofold. First we describe the value of conveying structural knowledge and the use of graphic techniques to convey this knowledge. Second, we present a model which describes differential learning outcomes of a variety of graphic techniques based upon the technique's attributes and the types of cognitive processes that are elicited when the graphics are constructed.

Structural Knowledge

Structural knowledge is an important construct in learning and instruction for several reasons: 1) structure is inherent in all knowledge, 2) structural knowledge is essential to comprehension, 3) learners acquire structural knowledge as a natural outcome of instruction, 4) experts represent structural knowledge differently from novices, and 5) structural knowledge is essential to problem solving.

1) Structure is inherent in all knowledge. "Meaning does not exist until some structure, or organization, is achieved" (Mandler, 1983, p. 4). Without structure, mental constructs could not be formed, because nothing could be described. The more abstract the ideas are, the more important structure becomes.

2) Therefore, structural knowledge is essential to comprehension. We naturally and necessarily organize our mental representations of phenomena in order to be able to access them. Structural knowledge has greater importance as the task increases in complexity. For instance, meaning for text evolves from story schemas (structures) that readers construct by integrating them with exisiting knowledge structures. Bruner (1960) believed in the need to teach students how ideas or concepts within a content area are linked, arguing that failure to learn this structural information results in an inability to comprehend ideas and transfer them to new situations. Acquiring knowledge about the structure of a content area allows learners to better comprehend and retain content and apply it to new situations. Bruner believed that "knowledge one has acquired without sufficient structure to tie it together is knowledge that is likely to be forgotten" (Bruner, 1960, p 31).

3) Learners acquire structural knowledge as a natural outcome of instruction. As instruction progresses, the learners' conceptions of content (including structure) become more interrelated and correspond more closely with the teacher's content structure (Shavelson, 1974). So learners acquire structural knowledge, as well as declarative and procedural knowledge, from instruction.

4) Experts represent structural knowledge more efficiently and effectively than novices. Among the major differences between experts and novices is that experts' knowledge includes rich sets of pattern-indexed schemata that guide problem interpretation and solution (Larkin, McDermott, Simon, & Simon, 1980). These schemata are the expert's structural knowledge about his/her field. Experts develop more elaborate schemata and these richer schemata involve more complex structures that enable them to reason more effectively.

5) Structural knowledge is essential to problem solving. A number of research studies have demonstrated the importance of structural knowledge to problem solving (Chi & Glaser, 1985). The extent to which problem solving protocols contained relevant structural knowledge is the strongest predictor of how well learners solve transfer problems in

physics (Robertson, 1990). Domain-specific problem solving relies on adequate and appropriate knowledge structures.

The acquisition of structural knowledge is integral to recall, comprehension, and transfer. Structural knowledge provides a semantic foundation for the comprehension of materials and solution of domain-specific problems. Therefore, it is important to facilitate the construction and acquisition of structural knowledge during learning. One approach to facilitating structural knowledge acquisition is the explicit elicitation and communication of structural knowledge during learning and instruction. That is, knowledge structures are elicited from experts or experienced practitioners and mapped onto instructional materials. This mapping may be implicitly conveyed in the organization of the content or graphically depicted for the learner.

Graphic Techniques

Graphic techniques are spatial representations of structural knowledge in a content area. As noted above, these representations can be developed by experts and provided to learners to promote acquisition of structural knowledge. However, the purpose of this article is to examine the use of graphic techniques as learning strategies drawn by learners as they study material from texts, lectures, films and other media. Although each of the techniques can be used to depict structural knowledge, they differ from each other in appearance, types of relationships displayed, and the use and type of labels used to name concept relationships.

Appearance

The most obvious difference between graphic techniques is the format and appearance of the end product. Some types of graphics use a matrix format, others have lines connecting concept words, and another uses box-like frames sectioned into further squares and rectangles. The actual appearance of these graphics has little to do with their effectiveness in representing structural knowledge; however, those strategies with more complex appearances may be more difficult to learn or to interpret.

Types of Relationships

The number and types of relationships that are depicted by each technique also differs. Some convey hierarchical information in which concepts are subsumed by broader, more inclusive concepts. While this hierarchical information is a component of content structure, it depicts only a limited representation of that structure. Other spatial strategies permit the representation of a broader variety of relationships and interrelationships between concepts. This depiction of multiple interrelationships between concepts is referred to as a heterarchical structure.

Labelling

Some graphic techniques use no labels so that the relationships between concepts are not clearly defined. While the learner may mentally identify the type of relationship between concepts when developing the graphic representation, these relationships are not explicitly identified on the product. When multiple relationships are depicted confusion regarding the type of relationship between concepts may arise if no labels are used. The strategies that use labels to identify the type of relationship that exists between concepts may allow the learner to create their own labels, or use a predefined set of relationship types.

The type of labelling system has some impact upon the usefulness of the technique. If one attempts to represent a content area with an insufficiently inclusive labelling system, misinterpretations of the final product may result. On the other hand, those strategies which use prespecified labels require the person drawing the map to identify not only the concepts, but also the relationships between those concepts. An additional analysis is necessary to fit the relationship label into a prespecified taxonomy. There is some evidence that this extra processing requirement may be beneficial to learners. Holley and Dansereau (1984) reported that when a modified form of networking using learner-generated labels was field tested, learners with high verbal ability benefitted from the networking strategy, but learners with low verbal ability did not. Low verbal ability learners showed greater retention and recall of content when they used prespecified labels of relationships.

While the appearance of the graphic and the use of labels to identify relationship type may impact learning, the most important difference between representational strategies appears to be the types of relationships depicted. More specifically, it seems that the primary difference in learning outcomes is dependent upon whether the representations are strictly hierarchical or if they allow for depiction of multiple (heterarchical) relationships.

Graphic techniques used as learning tools include semantic maps, semantic features analysis, spider maps, structured overviews, pattern notes, concept maps, networks, text maps and schematizations. In the following section each of these representations are described in terms of the three attributes described above.

Types of Graphic Learning Tools

Graphic techniques that utilize a hierarchical structure vary in their visual format--using linear, matrices, or web-like representations. The ***structured overview*** (later renamed *graphic organizer)* uses a linear representation in which the most important topic of a passage or a lesson is listed at the top, with important sub-topics presented underneath, and further sub-topics for each of them listed next (Barron 1969, 1980). The organizer continues until all of the important ideas are included on the graphic. Thus, hierarchical relationships between terms are shown through the use of unlabeled lines (see Figure 1 for example).

Insert Figure 1 about here

The ***semantic features analysis*** is another hierarchical graphic technique that that utilizes a matrix rather than lines to depict relationships (Johnson, Toms-Bronowski, and Pittleman, 1982; Johnson, Pittleman, Toms-Bronowski, Levin, 1984). In order to perform this technique, the general topic of instruction is selected, and words related to the topic are identified and listed in a column (see Figure 2 for example). Then features shared by some or all of the words are listed in a row across the top, forming a matrix. Next, learners indicate whether each concept has each of the features by putting a "+" or a "-" in each of the boxes corresponding to the concept and the feature.

Insert Figure 2 about here

Semantic maps and ***spider maps*** use a web-like format rather than a linear structure. ***Semantic mapping*** (Johnson et al, 1982; Pittleman, Levin, and Johnson, 1985; Johnson et al, 1984; Heimlich and Pittleman,1986) is relatively simple. A general topic is defined and written in the center of a piece of paper (or chalkboard).

Then concepts that are related to the main topic are identified and connected around the main topic in a web-like fashion with unlabelled lines. Examples of these secondary concepts are identified and simply listed beneath these concepts. Thus, a three-tiered hierarchy of concepts is generated and graphically represented. (See Figure 3 for example).

Insert Figure 3 about here

A *Spider Map* is a graphic technique developed by Hanf (1971) as an alternative to traditional notetaking from text. In spider mapping, the main idea of the text passage is written in the center of a page, and related, subordinate concepts are drawn on lines connected to the central idea (see Figure 4 for example). Additional lines with increasingly detailed content can be added to the drawing, with the end product resembling a spider web.

Insert Figure 4 about here

The next group of spatial techniques utilizes interrelational, heterarchical representations. Examples of this technique include pattern notes, concept maps, semantic networks, schematization, and text maps.

Pattern notes, a technique very similar to spider mapping, was developed originally as *brain patterns* by Buzan (1974) and subsequently retermed *pattern notes* (Fields, 1982; Jonassen, 1984, 1987) (See example in Figure 5). Like spider maps, pattern notes are drawn in a free-flow, unconstrained manner. The pattern note is created by writing the main topic on the center of a page, with a box drawn around it. Then related ideas are drawn on lines connected to the center box. Additional lines and ideas are added, forming multiple layers around the central idea until all of the important ideas about the topic have been included on the note. A final step in the pattern noting process, which distinguishes this technique from spider mapping, is to draw additional lines linking ideas to show interrelationships between concepts.

Insert Figure 5 about here

A modification of pattern notes was developed by Jonassen (1984) to allow for labelling of relationships between concepts. Without labels, pattern notes can be difficult to interpret, as one cannot be certain of the type of relationship represented by the connecting lines. Thus, strategies that include labels of the relationships can be helpful in clarifying content structure. *Labelled pattern notes* use predefined symbols to depict the relationships that exist between concepts.

Concept maps (Novak and Gowin, 1984, Novak, 1980, 1981; Stewart, Van Kirk and Rowell, 1979; Stewart, 1984) consist of concepts, or "nodes" linked by labeled lines to show relationships and interrelationships between terms. Unlike pattern noting, in concept maps the concepts are arranged hierarchically, so that the most inclusive, subsumptive concepts appear at the top of the map, with less inclusive, subordinate concepts below (see example in Figure 6). Like pattern notes, heterarchical relationships between concepts are depicted by lines. Here, labels of the relationship type are simply words selected by the learner, rather than symbolic labels representing a fixed set of relationship types.

Insert Figure 6 about here

Networking (Dansereau, 1978; Dansereau, Collins, McDonald, Holley, Garland, Diekhoff and Evans, 1979; Dansereau and Holley, 1982; Dansereau, McDonald, Collins, Garland, Holley, Diekhoff and Evans, 1979; Holley and Dansereau, 1984) is a text mapping strategy developed as part of an overall study strategy. To create a network one first identifies the key concepts in a subject area, and then displays the interrelationships between these concepts using labelled lines (see example in Figure 7). Currently, networking employs six linkages which describe the relationships between concepts: "part of," "type of," "leads to," "analogy," "characteristic," and "evidence" (Holley and Dansereau, 1984). The first letter of each of these links is used to depict the type of relationship between concepts.

Insert Figure 7 about here

Schematizing (Mirande, 1984; Camstra & Van Bruggen, 1984) is another technique that uses concepts representing main ideas linked to other concepts via symbolic labels. Rather than specifying precise concept relationships the labels used in schematizations are: dynamic relationship, static relationship, similarity, interaction, and the negation of these four types of relationships. These relationships are symbolized by different types of lines linking concepts. Plain lines, lines with arrows at one or at both ends and double lines are used between concepts on schematizations. Schematizations include "specifications lists," which are lists and definitions of each of the concepts used in the schematization graphic (see Figure 8 for example).

Insert Figure 8 about here

Anderson (1979) and Armbruster and Anderson (1984) developed ***text maps*** as a technique to allow students to link ideas together and show their relationships. Maps consist of a general organizing structure, referred to as a frame. Within this frame learners map the relationships between ideas using symbols to represent seven different types of relationships that can exist between two ideas, or two special relationships which define or highlight the importance of a concept (see Figure 9 for example).

Insert Figure 9 about here

Selecting Appropriate Graphic Techniques: A Model

Selection of a graphic techniques to enhance learning should be based upon the desired performance outcomes. When examining the different effects and outcomes of these techniques it is helpful to consider the cognitive processes and strategies that are elicited when the representations are generated. We propose that different cognitive processes are induced by the cognitive strategies undertaken when creating the graphic. Cognitive processes are the manner of thinking and associating ideas, including analysis, elaboration, and integration of information. Cognitive strategies are the specific mental manipulations of information that are undertaken as part of the cognitive process. These in turn produce different effects and result in learning at different levels of cognitive performance. This model for selecting appropriate graphic techniques interrelates the cognitive processes of the various spatial representations with cognitive effects and performances, and is presented in Table 1.

Insert Table 1 about here

Cognitive Processes and Strategies

As noted previously, we propose that the most important characteristic of graphic learning techniques is whether they represent hierarchical or heterarchical relationships. Further, we propose that this difference is important because the development of hierarchical and heterarchical graphic techniques elicit different cognitive processes.

Analysis and elaboration are the types of cognitive processes that are used when developing hierarchical representations, such as semantic maps, semantic features analysis, structured overviews, and spider maps. Analysis is the breaking down of concepts into component parts, and the organization and categorization of those parts. This type of cognitive process is used in making all of the representations, but is particularly evident in the representations which have hierarchical formats. For example, note that the semantic map shown in figure 3 breaks down the large concept of "music" into important subordinate concepts, and further analyzes by identifying organizing those concepts into groups, and categorizing them.

The second type of cognitive process used in generating graphic techniques is elaboration. Elaboration is relating new knowledge to prior knowledge. There are three elaboration strategies that can be used when generating these graphic techniques: paraphrasing material, using imagery to picture new material in familiar contexts, and generating examples of new ideas from prior knowledge.

Heterarchical representations include concept maps, pattern notes, text maps, networks and schematizations. These representations use both analysis and elaboration but also allow for a third cognitive process: integration. Integration requires the learner to draw relationships between pairs of ideas from a new content domain. Integration can be accomplished by simply identifying interrelationships between the concepts displayed in the graphic. Alternatively, generation of analogies and/or metaphors requires the learner to consider the interrelationships between new ideas and relate these new ideas to prior knowledge.

Effects and Outcomes of Graphic Techniques

When considering the effects of graphic techniques it is helpful to frame the effects in terms of learning outcomes. One taxonomy of learning outcomes is provided by Component Display Theory (CDT) (Merrill, 1983). In CDT there are three levels at which concepts, principles or procedures can be learned: simple recall is referred to as the "remember" level; application of content is at the "use" level; and discovery of new concepts, principles or procedures requires that one "find" new knowledge.

We propose that learning tools that require analysis promote recall of content. Breaking "big" concepts into their component parts and organizing those parts should assist learners in remembering concepts. Prior research has indicated that categorizing ("chunking") concepts based upon similarities promotes recall of those concepts. Therefore technique of analysis seems most helpful in promoting recall of content, which would allow learners to perform at the "remember" level of learning.

Elaboration strategies are an important part of learning because as new information is linked to prior knowledge it becomes imbedded in existing knowledge structures, making it easier to recall and use the information. Mayer (1980, 1988) found that elaborations enhance learners' ability to transfer learning to new situations. In particular, it seems that elaborations such as paraphrasing and exemplifying are helpful in near transfer tasks in which the learning task is similar to those tasks presented in learning materials. In CDT terminology, ability to transfer learning to new problems in familar contexts requires learners to "use" that information. Since elaboration techniques are also helpful in recalling information, this model for selecting graphic techniques predicts that elaboration strategies would enhance learning at both the "remember" and "use" levels.

Since heterarchical representations incorporate both analysis and elaboration, recall and transfer of learning are facilitated when these techniques are used. In addition, integration of information helps to improve a learner's ability to draw inferences based upon that content (Mayer 1980, 1988). Inference is an important component of problem solving, and is requisite for learning at the "find" level.

To use this model for selecting between the various graphic techniques first consider the type of instructional outcome desired. If the objective is simply to recall the content at a later date appropriate graphic techniques would be hierarchical. If one must recall the content and be able to apply the knowledge to new situations transfer of learning is required. In this case hierarchical techniques are appropriate, but learners should be encouraged to elaborate when developing the graphic. Finally, if learners are expected to creatively solve problems after completing instruction, appropriate learning techniques should require integration of concepts. Therefore, heterarchical graphic techniques would be most appropriate.

Summary

Structural knowledge is an important component of learning in any content area. Graphic techniques illustrate the relationships between concepts, thereby conveying structural knowledge. These techniques can be used as learning tools to assist learners in acquiring structural knowledge and enhancing learning outcomes.

This paper presented a model which proposes different effects of these graphing strategies based upon the cognitive processes required to construct the graphic.

Hierarchically organized graphics require analysis and elaboration of content, and seem to enhance recall and transfer of learning. Heterarchical graphics require integration of content, which facilitates inference and therefore problem solving. While it is possible that other characteristics of the graphic techniques may affect learning outcomes, it is our contention that the primary differences will result from the types of cognitive processes induced when generating the graphics. However, research is needed to validate this model of strategy selection. In addition, research into the differential effects of learning strategies for learners with different aptitudes will assist instructional designers in prescribing appropriate learning tasks to optimize performance.

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Spatial Representation		Cognitive Process	Cognitive Effects	Cognitive Performance
Hierarchical	Stuructured Overview Semantic Map Semantic Feature Analysis Spider Map	Analysis Analysis Organization Categorization	Recall	Remember
		Elaboration Paraphrase Exemplify Imagery	Transfer	Use
Heterarchical	Concept maps Pattern Notes Text Maps Networks Schematizations	Integration Interrelate Ideas Create Analogies Create Metaphors	Inference	Find

Table 1. Model for selection of graphic techniques

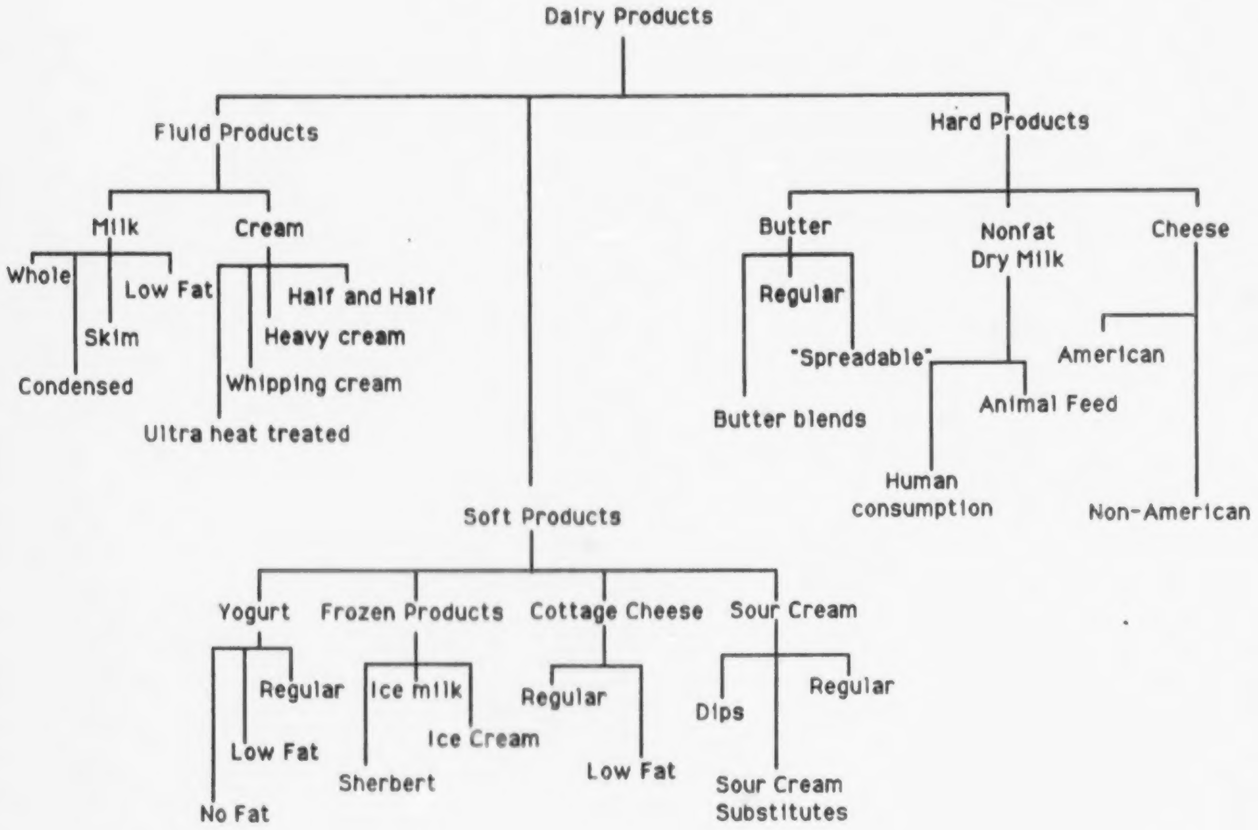
Dairy Products
Fluid Products
Hard Products
Milk
Cream
Whole
Low Fat
Skim
Condensed
Half and Half
Heavy cream
Whipping cream
Ultra heat treated
Butter
Regular
"Spreadable"
Butter blends
Nonfat Dry Milk
Animal Feed
Human consumption
Cheese
American
Non-American
Soft Products
Yogurt
Regular
Low Fat
No Fat
Frozen Products
Ice milk
Ice Cream
Sherbert
Cottage Cheese
Regular
Low Fat
Sour Cream
Dips
Regular
Sour Cream Substitutes

Figure 1. Structured overview

179

Forms of Government

	Economic Democracy	Political Democracy	Private Property	Dictatorship/Autocractic	Free Market	Welfare State
Communism	+	+	-	-	-	+
Socialism	+	-	-	+	-	+
Nazism	-	-	+	+	-	-
Capitalism	-	+	+	-	+	-

Figure 2. Semantic Features Analysis

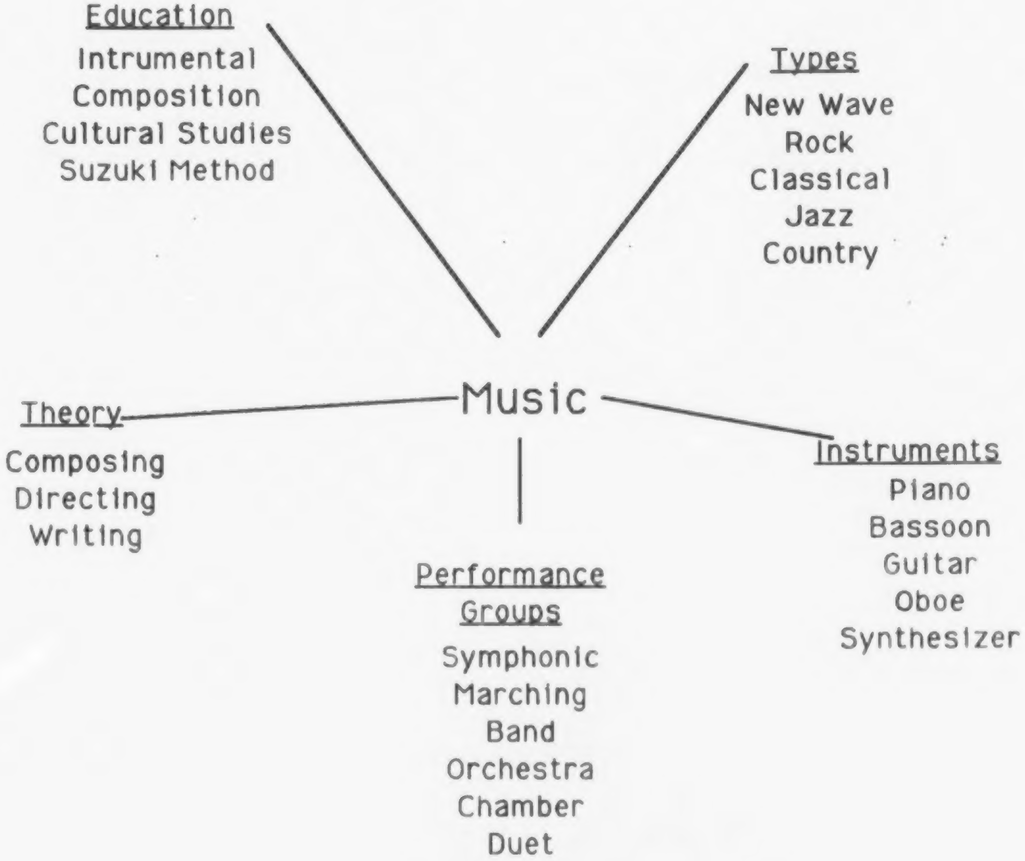
Education
Intrumental
Composition
Cultural Studies
Suzuki Method
Types
New Wave
Rock
Classical
Jazz
Country
Music
Theory
Composing
Directing
Writing
Instruments
Piano
Bassoon
Guitar
Oboe
Synthesizer
Performance Groups
Symphonic
Marching
Band
Orchestra
Chamber
Duet

Figure 3. Semantic Map

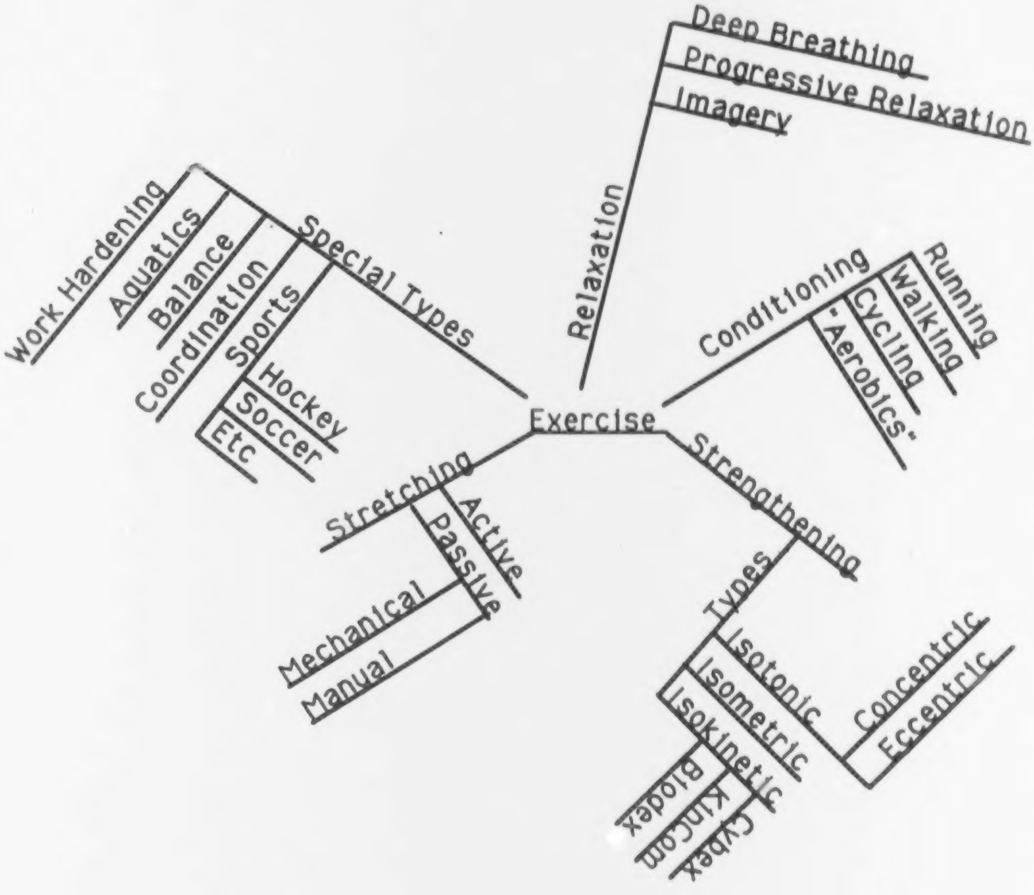
Exercise
Relaxation
Deep Breathing
Progressive Relaxation
Imagery
Conditioning
Running
Walking
Cycling
'Aerobics'
Strengthening
Types
Isotonic
Concentric
Eccentric
Isometric
Isokinetic
Biodex
KinCom
Cybex
Stretching
Active
Passive
Mechanical
Manual
Special Types
Work Hardening
Aquatics
Balance
Coordination
Sports
Hockey
Soccer
Etc

Figure 4. Spider Map

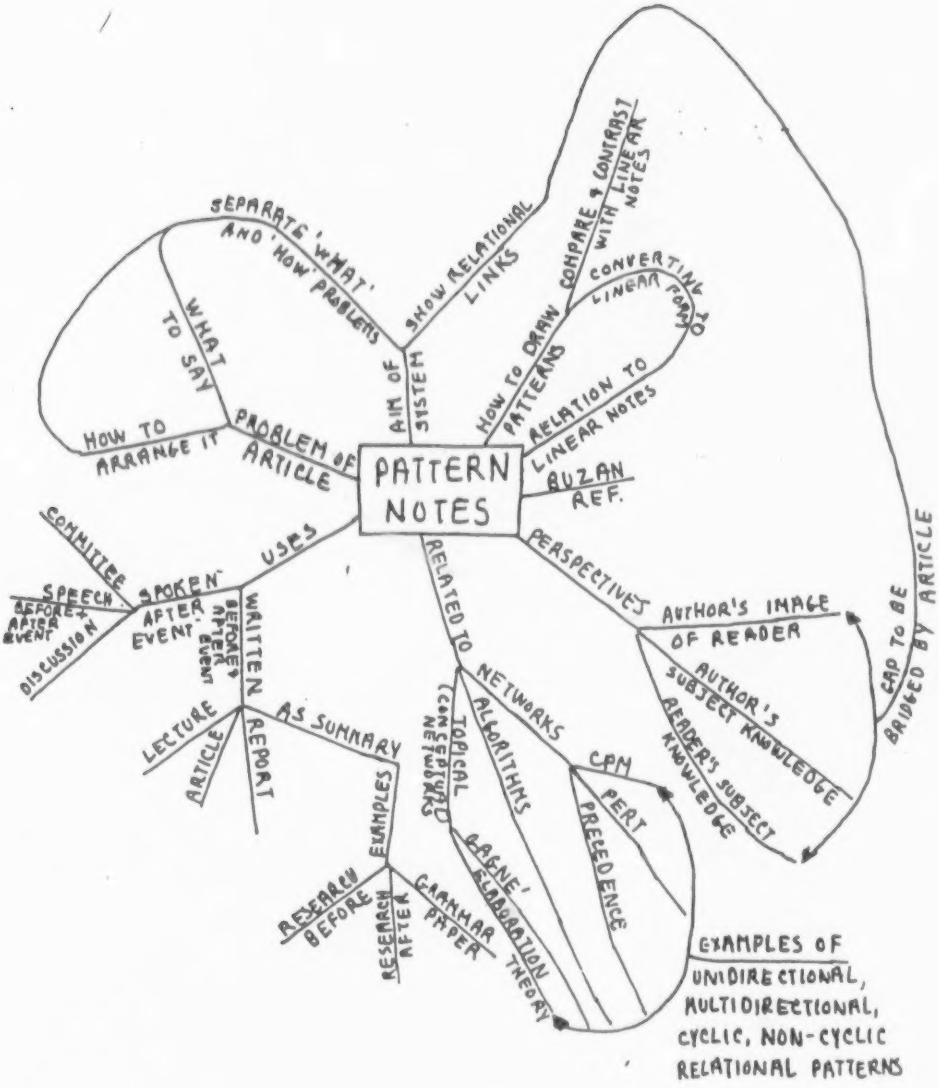
PATTERN NOTES
AIM OF SYSTEM
SHOW RELATIONAL LINKS
SEPARATE 'WHAT' AND 'HOW' PROBLEMS
WHAT TO SAY
HOW TO ARRANGE IT
PROBLEM OF ARTICLE
HOW TO DRAW PATTERNS
COMPARE & CONTRAST WITH LINEAR NOTES
CONVERTING TO LINEAR FORM
RELATION TO LINEAR NOTES
BUZAN REF.
PERSPECTIVES
AUTHOR'S IMAGE OF READER
AUTHOR'S SUBJECT KNOWLEDGE
READER'S SUBJECT KNOWLEDGE
GAP TO BE BRIDGED BY ARTICLE
RELATED TO NETWORKS
TOPICAL CONCEPTUAL NETWORKS
ALGORITHMS
CPM
PERT
PRECEDENCE
GAGNE' ELABORATION THEORY
EXAMPLES OF UNIDIRECTIONAL, MULTIDIRECTIONAL, CYCLIC, NON-CYCLIC RELATIONAL PATTERNS
USES
SPOKEN AFTER EVENT
COMMITTEE
SPEECH
BEFORE + AFTER EVENT
DISCUSSION
WRITTEN
BEFORE + AFTER EVENT
LECTURE
ARTICLE
REPORT
AS SUMMARY
EXAMPLES
RESEARCH BEFORE
RESEARCH AFTER
GRAMMAR PAPER

Figure 5. Pattern Note

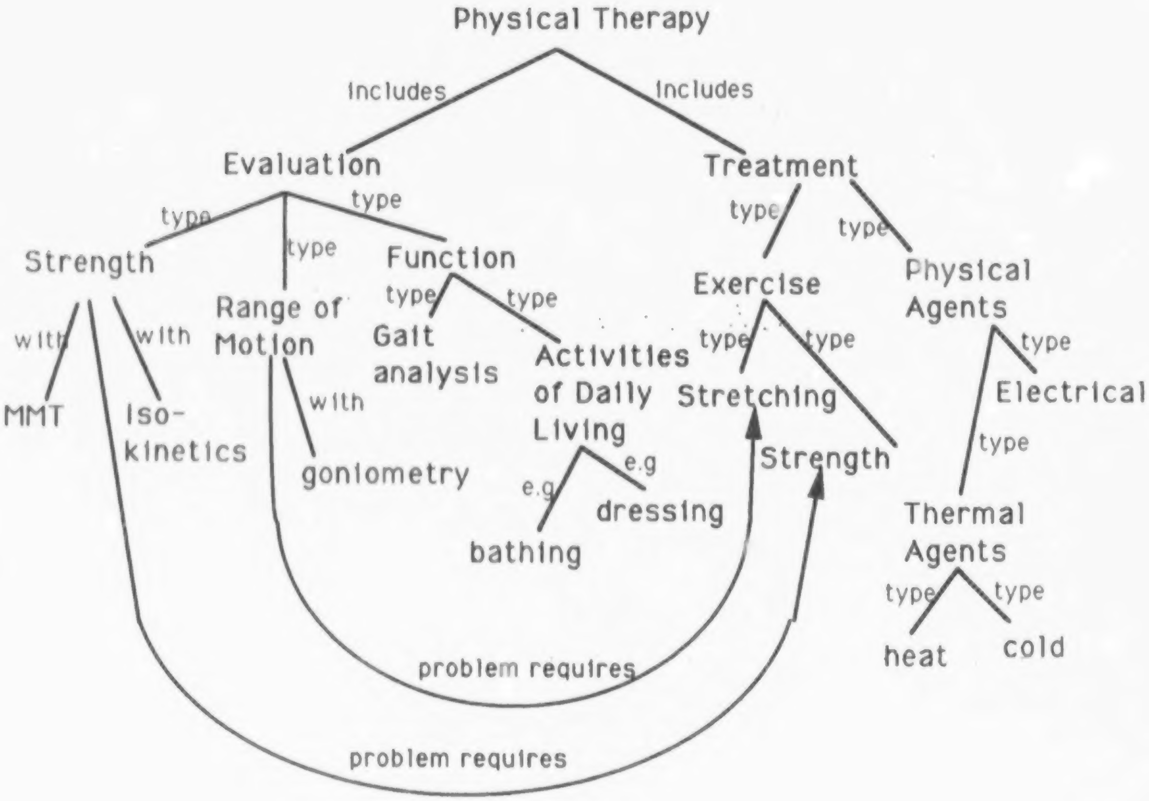
Physical Therapy
includes
includes
Evaluation
Treatment
type
type
type
Strength
Range of Motion
Function
with
with
with
MMT
Iso-kinetics
goniometry
type
type
Gait analysis
Activities of Daily Living
e.g
e.g
bathing
dressing
type
type
Exercise
Physical Agents
type
type
Stretching
Strength
type
Electrical
type
Thermal Agents
type
type
heat
cold
problem requires
problem requires

Figure 6. Concept Map

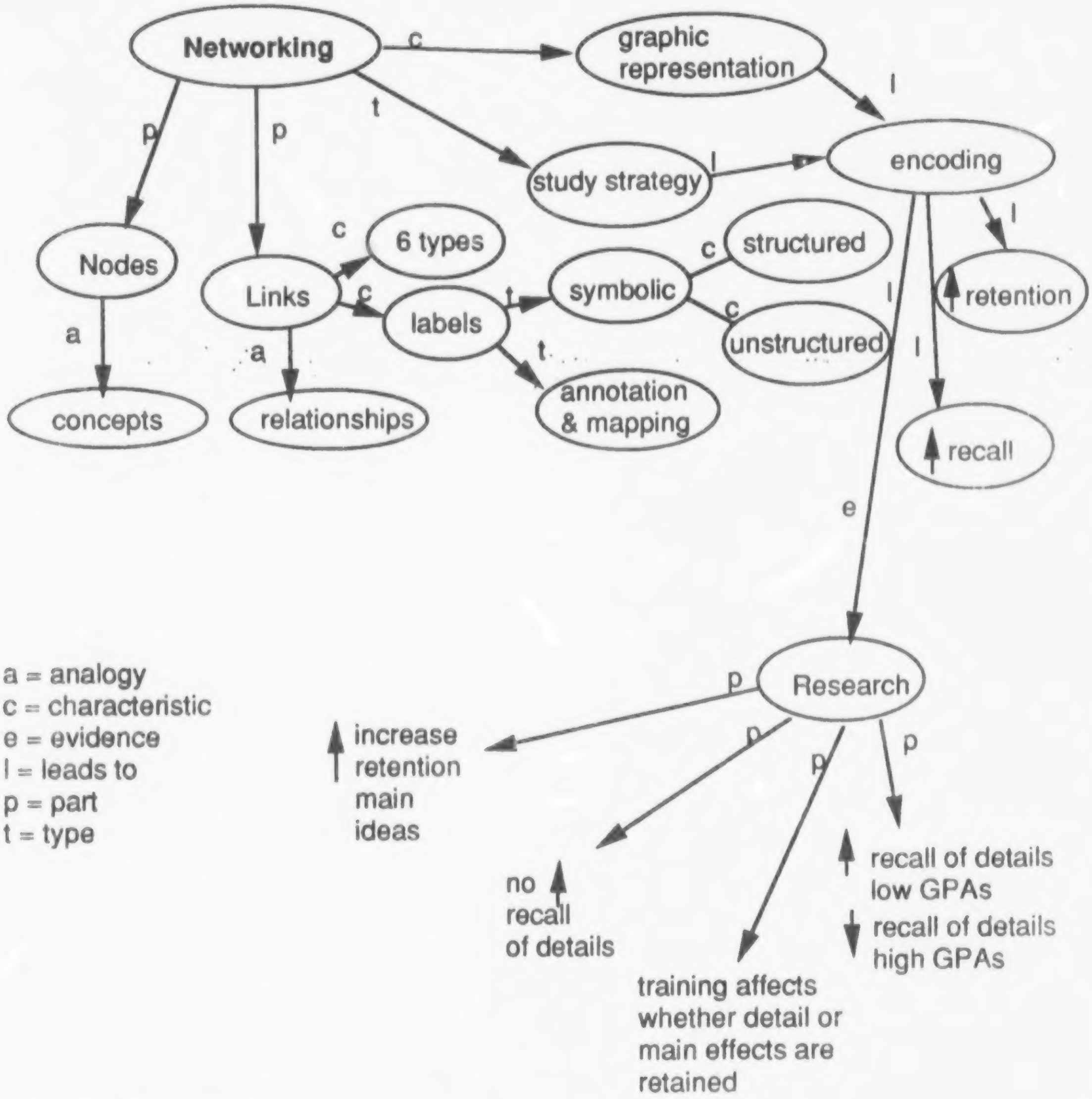
Networking
c
graphic representation
l
t
p
p
study strategy
l
encoding
l
c
6 types
Nodes
Links
c
labels
t
symbolic
c
structured
c
unstructured
l
retention
a
a
t
l
concepts
relationships
annotation & mapping
recall
e
a = analogy
c = characteristic
e = evidence
l = leads to
p = part
t = type
p
Research
increase retention main ideas
p
p
p
no recall of details
recall of details low GPAs
recall of details high GPAs
training affects whether detail or main effects are retained

Figure 7. Network

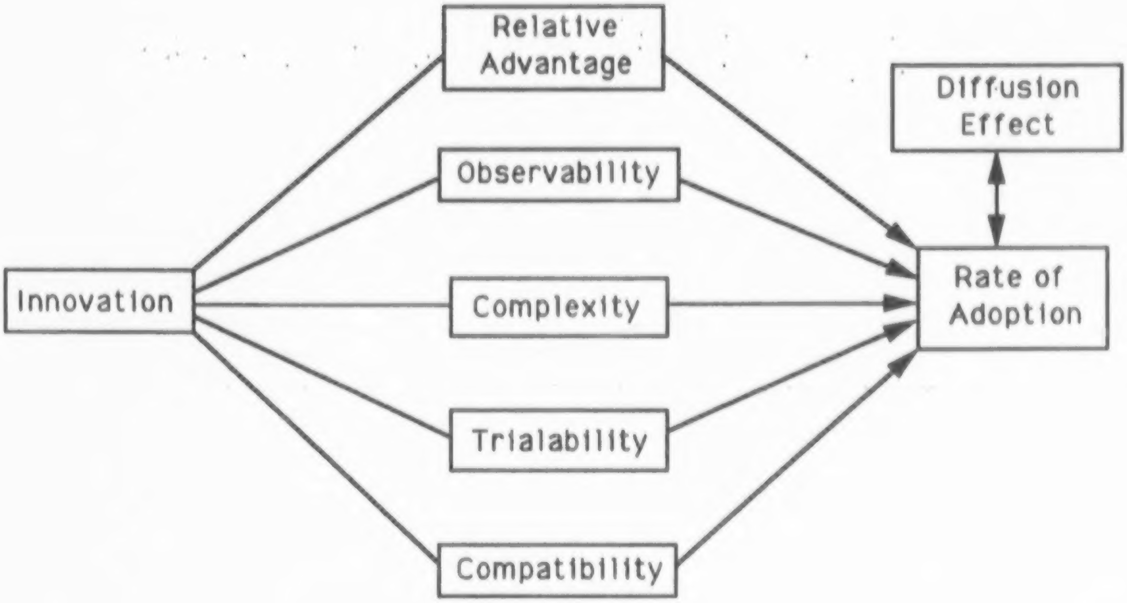
Relative Advantage
Observability
Complexity
Trialability
Compatibility
Innovation
Diffusion Effect
Rate of Adoption

Figure 8. Schematization

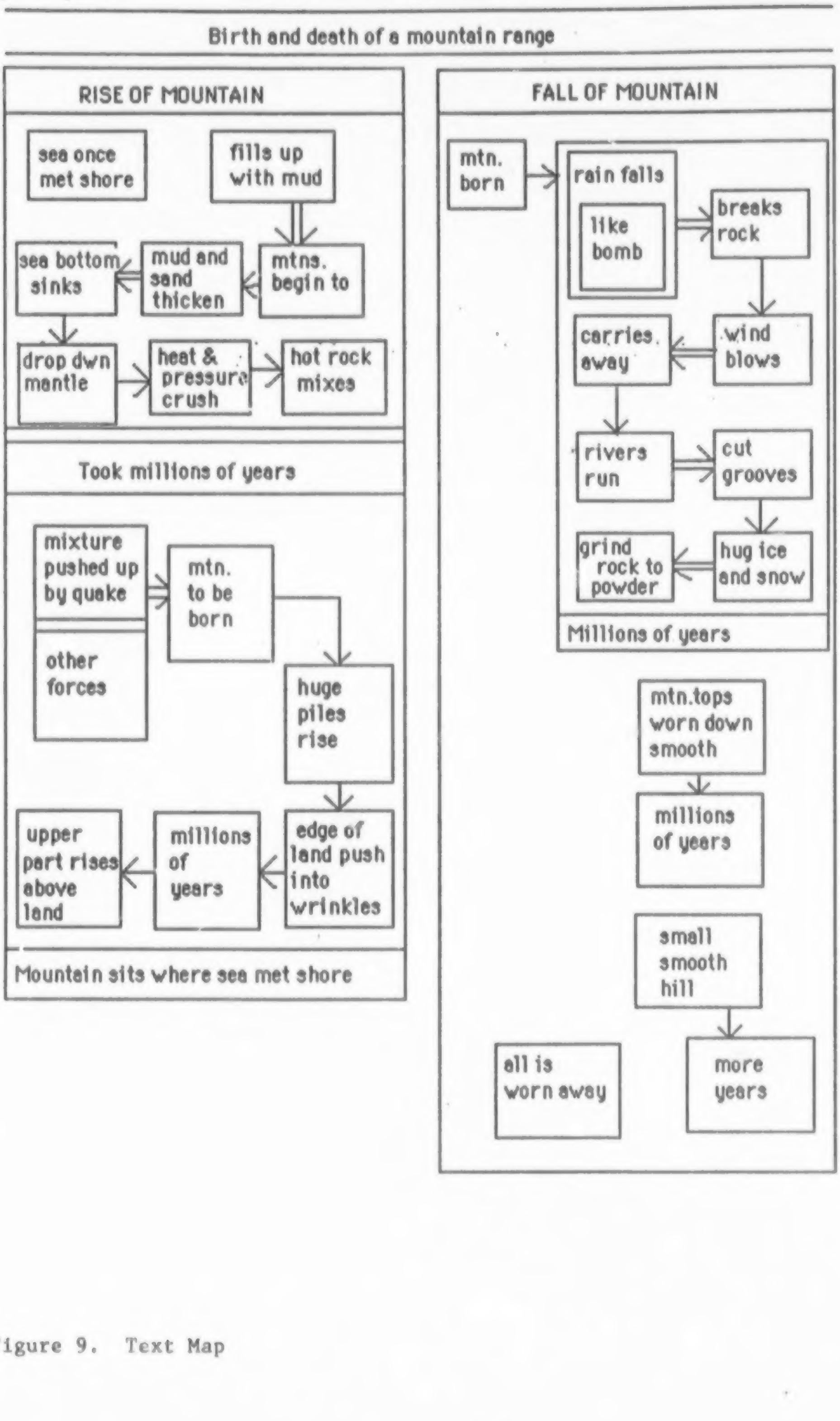
Birth and death of a mountain range
RISE OF MOUNTAIN
sea once met shore
fills up with mud
mtns. begin to
mud and sand thicken
sea bottom sinks
drop dwn mantle
heat & pressure crush
hot rock mixes
Took millions of years
mixture pushed up by quake
other forces
mtn. to be born
huge piles rise
edge of land push into wrinkles
millions of years
upper part rises above land
Mountain sits where sea met shore
FALL OF MOUNTAIN
mtn. born
rain falls
like bomb
breaks rock
wind blows
carries away
rivers run
cut grooves
hug ice and snow
grind rock to powder
Millions of years
mtn.tops worn down smooth
millions of years
small smooth hill
more years
all is worn away

Figure 9. Text Map

Title:

Factor Analyses of the Instructional Motivation Needs of Adult Learners

Authors:

Roy M. Bohlin
William D. Milheim
Karen J. Viechnicki

FACTOR ANALYSES OF THE INSTRUCTIONAL MOTIVATION NEEDS OF ADULT LEARNERS

Previous research suggests that motivation is related to interest and effort and that for some learners satisfaction is closely related to ones overall interest in an instructional environment. In order to learn more about the motivational factors of adult learners, data were collected regarding the instructional motivation perceptions of adults in a variety of learning environments. Factor analyses of these data provide for some support for the categories of the ARCS Model for Design of Motivating Instruction. Adults in university courses and workshops were found to have much different instructional needs than adults in community workshop classes. The responses of the subjects in community classes provided less support for the categories of Keller's work. The results, analyses, and implications are discussed.

A number of researchers (Aslanian & Brickel, 1980; Cross, 1981; Houle, 1961; Knowles, 1980; Zemke & Zemke, 1981) have in the past proposed that adult learners have very specific motivational needs in instructional settings. These needs may be the result of life experiences (Knowles, 1980), transitions in life (Cross, 1981), or learned attitudes over time as a major factor in adult learning (Wlodkowski, 1985). As a result, these authors recommend that instruction for adult learners be designed differently than other types of instruction.

More recently Galbraith (1990 & 1991) has built on this theory base, hypothesizing that facilitators and adult learners ought to be engaged in active, challenging, collaborative, critically reflective, and transforming educational encounters into a transactional process. The guiding principals focus on (a) an appropriate philosophical orientation; (b) the diversity of adult learners; (c) a conducive psychosocial climate; (d) the need for challenging interactions; (e) the promoting critical reflection; and (f) the encouragement of independence.

While the literature is rich with material about the needs of adult learners, there appears to be almost no evidence of actual research findings aimed at the identification of the instructional motivation needs of adults. Recently, Bohlin, and Viechnicki (1991) found that for a group of college students, motivation had two distinct components interest and effort. The analyses of their data also suggested some preliminary support for the categories of the ARCS Model for Design of Motivating Instruction -- attention, relevance, confidence, and satisfaction. The purpose of this study therefore was to investigate the primary factors of motivation for adults of various types in instructional environments.

MOTIVATIONAL INSTRUCTIONAL DESIGN

Instructional motivation attracts learners toward the instruction and increases their effort in relation to the subject (Keller, 1983). This means that instructional motivation has two components, it is interesting and effort generating. Motivational instruction, therefore, has appeal or interest for the learner and stimulates learner effort. This dual characteristic of instructional motivation has been supported in previous studies (Bohlin, Milheim, & Viechnicki, 1990a & b).

Keller (1987), Keller and Suzuki (1988), and Keller and Kopp (1987) also identify four categories of motivation in learning situations: attention, relevance, confidence, and satisfaction (ARCS). To facilitate continuing motivation, strategies in these four categories should be addressed. The ARCS model contains specific methods or strategies, that are aimed at producing motivational outcomes, when learners are lacking sufficient conditions, such as interest or motives. The initials of these four categories (attention, relevance, confidence, and satisfaction) give Keller's model the acronym ARCS.

The initial requirement for motivating instruction is to gain and maintain the *attention* of the learner. This can be achieved through procedures that take advantage of the curiosity, interest, or arousal of the students by using humor, variety, enthusiasm, etc. Second, the instruction must have perceived *relevance* to the immediate or long-range personal needs of the learner. These personal needs can be met by matching the instruction to learners' goals, making the benefits clear, keeping the challenge level appropriate, etc. Next the instruction must provide for the *confidence* of the learner. The instruction must promote the learner's expectancy for success or failure, which influences the actual effort and performance, and can be increased by strategies such as clearly indicating the requirements for success, providing a low risk environment, and giving accurate attributional feedback. Lastly, the instruction should provide individual *satisfaction* in order to facilitate continuing motivation. Learners must perceive the rewards gained as fair, equitable, and consistent while meeting their expectations. Learner satisfaction can be promoted by providing appropriate recognition for success, giving informative and corrective feedback, etc.

These strategies and categories were the basis for the development of two needs assessment instruments. The instruments, emphasizing *interest* and *effort* , were used in this study. The research questions are (a) What are the primary motivational factors for adults in instructional settings? (b) Are these factors different for adult college students and adults from the general population? (c) How do these students' needs differ in regards to interest and to effort?

METHODOLOGY

Instruments

The instruments used in this study were the Course Interest Survey Revised (CISR) and the Course Effort Survey Revised (CESR). These instruments were developed through a series of revisions (Bohlin, Milheim, & Viechnicki, 1990a; Bohlin, Milheim, & Viechnicki, 1990b; and Viechnicki, Bohlin, & Milheim, 1990). The original instrument was developed by Keller and Subhiyah (1987) to evaluate the percieved degree of motivational effects of instructional materials. After rewording the items and deleting those items not consistent with evaluation of classroom instruction, several items were added which were identified in the literature as specifically important to the instructional motivation of older learners.

The purpose of these instruments is to identify the instructional motivation needs of learners. Each instrument is composed of the same 42 items, which are a selection of strategies which have been identified in the literature as having motivational effects on learners of various ages (See Table 1). The instruments only differ in asking the subjects to rate the importance of each (of the 42 strategies) on their own *interest* and *effort* , respectively.

The instruments might be used to determine the motivational needs of specific individuals or of specific classes. They also can be used to measure the needs of a representative group of a population with the intent of obtaining generalizable prescriptions for that population.

Subjects

The subjects in Phase 1 of this study were a mixture of 183 graduate and undergraduate students enrolled in credit and non-credit classes at four medium-sized state universities across the U.S. These classes were offered through Colleges of Education, and represented a variety by content and methods of delivery. The average age of the subjects in this sample was 38 years. Fifty-seven percent of the subjects were female. These students responded to the CISR and the CESR.

The subjects in Phase 2 of this study were 147 students enrolled in community adult education classes in a suburb of a large midwestern city. These classes represented a wide variety by content and methods of delivery. The average age of the subjects in this sample was 46 years. Fifty-one percent of the subjects were female. These subjects were only given the CISR.

While return rates were approximately 96% for phase 1 and 86% for phase 2, an additional 6% and 3%, respectively, of the returned response sheets were discarded due to incomplete or out of range responses.

Analyses

The instruments were administered during regular class time and collected. Responses were made on scan sheets. Sheets were either scanned or hand entered to make the responses available for analysis. Data were analyzed using *Statview 512+* on a Macintosh LC computer. Analyses included means and standard deviations for each of the items. Comparisons of the means identified those items that were rated as most important to the subjects' interest and effort in instructional settings.

Additional analyses included orthogonal transformation solution-varimax factor analysis. These analyses were performed in order gain some insight into the nature of the response patterns of the subjects and to examine the degree of support for the ARCS model as identifiable categories.

RESULTS

Phase 1 - College students

Analyses of the responses to the items showed that the strategies were ranked highly by the subjects. Several were rated very highly by subjects on both sets of instruments. Others were rated relatively high on only one of the instruments. A listing of those highly rated items (the letter and number identify the subscale and subscale item number) for each of the instruments follows.

Strategies reported as most important to the subjects' **interest** (in order of reported importance):

C6	Requirements for success are made clear to me
R1	Information I learn will be useful to me
R3	Benefit from the knowledge acquired in the class
S9	Feel satisfied with what I learn
A1	Makes me feel enthusiastic about subject
C9	Get enough timely feedback to know how well I am doing
S8	Amount of work I have to do is appropriate
C10	Instructor models and demonstrates proper skills during instruction
R12	Personally benefit from what I learn in the class

Strategies reported as most important to the subjects' **effort** (in order of reported importance):

C6	Requirements for success are made clear to me
R1	Information I learn will be useful to me
R3	Benefit from the knowledge acquired in the class
S2	Can set and achieve high standards of excellence
A1	Makes me feel enthusiastic about subject
S8	Amount of work I have to do is appropriate
C9	Get enough timely feedback to know how well I am doing
C4	Whether or not I succeed is up to me

The three highest ratings by the subjects in this phase were the same (in order) for both instruments: (a) clearly stated requirements for success, (b) learning of personally useful information, and (c) knowledge acquired is beneficial. Three other items were ranked highly on both instruments: (a) makes me feel enthusiastic about subject; (b) get enough timely feedback to know how well I am doing; and (c) amount of work I have to do is appropriate

Results of the factor analyses showed that for the CESR the first four factors were principally the four categories of strategies proposed by the ARCS model---Confidence, Relevance, Attention, and Satisfaction, respectively (See Table 5). For the CISR, results were less definite. Further analysis, showed that removal of the Satisfaction category items from the data before performing the factor analysis resulted in a very clean separation of items from the other categories into the first three factors of Confidence, Relevance, and Attention, respectively (See Table 6).

Phase 2 - Community education students

Analysis of the items showed that most items were rated very high on the CISR by these subjects (the CESR was not administered to this population). The responses showed a pattern of higher ratings than the college students on nearly every item. A ceiling effect may have effected these data, as many items had means within one standard deviation of the highest possible rating. A listing of the items most highly rated (the letter and number identify the subscale and subscale item number) follows:

Strategies reported as most important to the subjects' **interest** (in order of reported importance):

S1	Gives me a lot of satisfaction
R11	Content relates to my expectations and goals
C10	Instructor models and demonstrates proper skills during instruction
C5	Creates a relaxed classroom atmosphere
C4	Whether or not I succeed is up to me
C3	Builds my self-esteem
R12	Personally benefit from what I learn in the class
C2	Makes me feel I have the ability to succeed
R1	Information I learn will be useful to me

Results of the factor analyses showed that for the CISR, the factors were mixed. Further analysis, with these responses showed that removal of the Satisfaction category items from the data before performing the factor analysis resulted in a better placement of items, but the factors were not as "pure" as expected (See Table 6).

DISCUSSION

All 42 of the strategies in the instruments received mean responses by all of the subjects in the range of important to necessary to their interest or effort in instructional settings. While both scales shared some of their highest rated items for college students, six of the top nine, there were definite differences in the results of the factor analyses between the two instruments and between the two groups.

The results of the first factor analysis (of the effort responses of learners in college classes) gave some support to the categories of the ARCS model with the each of the first four factors entirely or predominately composed of items from one category each -- Confidence, Relevance, Attention, and Satisfaction respectively (See Table 6). This suggests that the theoretical nature of the categories in the ARCS model are consistent with the nature of the self-reported motivational needs of adults in college courses and workshops. This also supports the traditional type of definition of motivation which usually refers to time on task or some other measure of effort.

The results of the second factor analysis (of the interest responses of learners in college classes) gave factors that were highly mixed. Repeating the factor analysis after removing the Satisfaction items yielded a very good separation of category items into the first three factors -- Confidence, Relevance, and Attention (See Table 5). This suggests that when considering learners' interest, satisfaction may be intimately interrelated with the other categories' strategies. Another explanation might be that these learners find it difficult to differentiate the effects of satisfaction-oriented strategies from others when referring to their own interests.

The fact that the top three responses to both instruments were the same may suggest that instructional strategies perceived as the most important for interest are also important for effort. An alternative explanation is that for very important strategies, subjects have difficulty differentiating between the effects of interest and effort.

A comparison of the highest rated items on the CISR for the two different groups show striking differences. The adults in the community education workshops rated nearly all of the items as much more important. This supports that hypothesis these adults from the general population have much lower levels of intrinsic motivation in classes, and feel a greater need for extrinsic motivation. In addition, these learners report a greater need for confidence-building strategies -- five of the top nine items were from the category of confidence. This suggests that the lower intrinsic motivation of theses learners may be related to lower level of confidence in their ability to succeed in a formal learning environment.

The omission of attention-related strategies from the highest rated items for the non-college adults, can be explained by the fact that they are taking classes that are completely optional, ones that they have probably selected because of a strong interest in the topic. They therefore would not need strategies intended to hold their attention, in spite of reported shorter attention spans for older adults. This is further supported by the fact that the second highest item for this group was that the "content relates to my expectations." Their interest is in fact very dependent upon how closely the content matches their expectations when enrolling in the class. The uniquely high ranking of the confidence item that referred to building the learners' self-esteem was noteworthy. It would seem that adults from the general population, have lower self-esteem and therefore have a greater need for instructor facilitation in this regard.

The three highest-rated items for the adults in the college classes were not among the highest rated items for the other group. The first, that the requirements for success are clear, is probably related to grades and their importance to that group. The second, that information will be useful, and the third, that they benefit from the knowledge obtained in the class, reflect on the usual relevance of college courses to students' occupations.

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Table 1

Content of items in both the Course Interest Survey Revised (CISR) and the Course Effort Survey Revised (CESR) by subscales

Attention:	1	Makes me feel enthusiastic about subject
	2	Content captures my attention
	3	Makes the subject matter seem important
	4	Shows how the content relates to things I already know
	5	Uses humor during instruction
	6	Makes me feel curious about the subject matter
	7	Does unusual or surprising things that are interesting
	8	Uses an interesting variety of teaching techniques
	9	Curiosity is often stimulated by the questions asked or the problems given
Relevance:	1	Information I learn will be useful to me
	2	Allows time for practical application of the content
	3	Benefit from the knowledge acquired in the class
	4	Actively participate in the class
	5	Positive role models be presented to me in class
	6	Is flexible to meet my needs in content and assignments
	7	Personal benefits of the course are made clear to me
	8	Challenge level is about right
	9	Have some input or choice in content and assignments
	10	Get a chance to work with other people in the class
	11	Content relates to my expectations and goals
	12	Personally benefit from what I learn in the class
Confidence:	1	Helps me feel confident that I can do well
	2	Makes me feel I have the ability to succeed
	3	Builds my self-esteem
	4	Whether or not I succeed is up to me
	5	Creates a relaxed classroom atmosphere
	6	Requirements for success are made clear to me
	7	Frequent opportunities to succeed
	8	Helps me to believe I can succeed if I try hard enough
	9	Get enough timely feedback to know how well I am doing
	10	Instructor models and demonstrates proper skills during instruction
	11	Non-threatening
	12	Designed so that everyone can succeed
Satisfaction:	1	Gives me a lot of satisfaction
	2	Can set and achieve high standards of excellence
	3	Fair recognition compared to other students
	4	Instructor's evaluations of my work match how well I think I have done
	5	Helps me to accomplish my own personal goals
	6	Feel satisfied with how the class is run
	7	Get enough recognition for my work through feedback
	8	Amount of work I have to do is appropriate
	9	Feel satisfied with what I learn

Table 2

Means and standard deviations of responses to each item in subscales in the Course Interest Survey Revised (CISR) *by students enrolled in college courses or workshops*

Sequence Number	Attention	Relevance	Confidence	Satisfaction
1	**1.95 (.87)**	**1.80 (.80)**	2.29(.99)	2.37(.89)
2	2.06(.82)	2.09(.94)	2.30(1.02)	2.22(.89)
3	2.12(.80)	**1.91 (.78)**	2.76(1.08)	2.52(.97)
4	2.31(.83)	2.92(1.06)	2.24(1.08)	2.23(.82)
5	2.68(1.10)	2.91(1.13)	2.32(.95)	2.93(1.03)
6	2.29(.85)	2.47(1.08)	**1.75 (.81)**	2.55(.89)
7	3.05(1.00)	2.54(.90)	2.05(.82)	2.47(.87)
8	2.34(.98)	2.32(1.00)	2.53(1.01)	**2.03 (.82)**
9	2.25(.82)	2.84(1.03)	**2.00 (.93)**	**1.93 (.78)**
10		3.12(1.03)	**2.04 (.86)**	
11		2.30(.88)	2.30(1.13)	
12		**2.04 (.85)**	2.47(1.17)	

Key: 1 = necessary or essential
2 = very important
3 = important
4 = slightly important
5 = not important

Bold = Top ranked items in CISR

N = 183

Table 3

Means and standard deviations of responses to each item in subscales in the Course Effort Survey Revised (CESR) *by students enrolled in college courses or workshops*

Sequence Number	Attention	Relevance	Confidence	Satisfaction
1	**1.96 (.92)**	**1.90 (.84)**	2.42(.99)	2.38(1.01)
2	2.30(.87)	2.25(.89)	2.73(1.05)	**1.92 (.85)**
3	2.36(.85)	**1.91 (.82)**	2.94(1.13)	2.32(1.07)
4	2.59(1.04)	2.90(1.04)	**2.07 (1.10)**	2.13(.89)
5	2.91(1.12)	3.01(1.12)	2.49(1.03)	3.10(1.10)
6	2.28(.80)	2.52(.97)	**1.79 (.86)**	2.51(1.02)
7	3.26(1.06)	2.74(1.16)	2.09(1.01)	2.47(1.04)
8	2.71(1.06)	2.26(.96)	2.58(1.14)	**2.04 (.85)**
9	2.45(.96)	3.05(1.05)	**2.05 (.89)**	2.09(.88)
10		3.23(1.14)	2.29(1.05)	
11		2.35(.92)	2.52(1.15)	
12		2.13(.94)	2.63(1.17)	

Key: 1 = necessary or essential
2 = very important
3 = important
4 = slightly important
5 = not important

Bold = Top ranked items in CESR

N = 183

Table 4
Means and standard deviations of responses to each item in subscales in the Course Interest Survey Revised (CISR) *by students enrolled in adult community workshops*

Sequence Number	Attention	Relevance	Confidence	Satisfaction
1	1.59 (.66)	**1.29 (.80)**	1.35 (.52)	**1.22 (.42)**
2	1.33 (.49)	1.62 (62)	**1.29 (.46)**	1.31 (.51)
3	1.31 (.49)	2.03 (.53)	**1.28 (.47)**	1.97 (.65)
4	1.31 (.52)	1.78 (.78)	**1.26 (.47)**	2.10 (.44)
5	1.42 (.64)	1.57 (.62)	**1.25 (.64)**	1.91 (.54)
6	2.08 (.46)	1.46 (.59)	1.97 (.51)	1.95 (.55)
7	2.61 (.80)	1.42 (.60)	2.10 (.47)	2.08 (.57)
8	1.99 (.56)	1.41 (.53)	1.45 (.58)	1.87 (.62)
9	1.37 (.60)	2.13 (.71)	1.72 (.61)	1.35 (.49)
10		2.42 (.89)	**1.25 (.45)**	
11		**1.23 (.42)**	1.64 (.70)	
12		**1.28 (.51)**	1.63 (.72)	

Key: 1 = necessary or essential
2 = very important
3 = important
4 = slightly important
5 = not important

Bold = Top ranked items in CISR

N = 147

Table 5

Items arranged and ranked by weightings in the top factors of the CESR *by students enrolled in college courses or workshops*

Factor 1 (Confidence)

C8	Helps me to believe I can succeed if I try hard enough
C3	Builds my self-esteem
C2	Makes me feel I have the ability to succeed
S7	Get enough recognition for my work through feedback.
C1	Helps me feel confident that I can do well
S5	Helps me to accomplish my own personal goals
C9	Get enough timely feedback to know how well I am doing
C12	Designed so that everyone can succeed

Factor 2 (Relevance)

R12	Personally benefit from what I learn in the class
R3	Benefit from the knowledge acquired in the class
S9	Feel satisfied with what I learn
R1	Information I learn will be useful to me
R8	Challenge level is about right
R2	Allows time for practical application of the content
R7	Personal benefits of the course are made clear to me

Factor 3 (Attention)

C10	Instructor models and demonstrates proper skills
A8	Challenge level is about right
A3	Makes the subject matter seem important
A5	Uses humor during instruction
R5	Positive role models be presented to me in class
A9	Curiosity is often stimulated

Factor 4 (Satisfaction)

S3	Recognition I receive is fair
S8	Amount of work I have to do is appropriate
S7	Get enough recognition for my work through feedback
S4	Instructor's evaluations of my work match how well I think I have done
S6	Feel satisfied with how the class is run

Factor 5

R9	Have some input or choice in content and assignments
R10	Get a chance to work with other people in the class
S6	Feel satisfied with how the class is run

Table 6

Items (with satisfaction items removed) arranged and ranked by weightings in the top factors of the CISR *by students enrolled in college courses or workshops*

Factor 1 (Confidence)

C3	Builds my self-esteem
C8	Helps me to believe I can succeed if I try hard enough
C1	Helps me feel confident that I can do well
C2	Makes me feel I have the ability to succeed

Factor 2 (Relevance)

R3	Benefit from the knowledge acquired in the class
R1	Information I learn will be useful to me
R12	Personally benefit from what I learn in the class
R8	Challenge level is about right

Factor 3 (Attention)

A3	Makes the subject matter seem important
A2	Content captures my attention
A1	Makes me feel enthusiastic about subject
C2	Makes me feel I have the ability to succeed

Factor 4 (Success & Relevance)

C6	Requirements for success are made clear to me
C7	Frequent opportunities to succeed
R9	Have some input or choice in content and assignments
R7	Personal benefits of the course are made clear to me

Factor 5 (Fun)

A5	Uses humor during instruction
A7	Does unusual or surprising things that are interesting
C5	Creates a relaxed classroom atmosphere

Factor 6 (Curiosity)

A6	Makes me feel curious about the subject matter
A9	Curiosity is often stimulated

Factor 7 (Support)

C12	Designed so that everyone can succeed
C11	Non-threatening
C10	Instructor models and demonstrates proper skills

Factor 8 (Active)

R10	Get a chance to work with other people
R4	Actively participate in the class

Table 7

Items (with satisfaction items removed) arranged and ranked by weightings in the top factors of the CISR *by students enrolled in adult community workshops*

Factor 1 (Confidence)

C4	Whether or not I succeed is up to me
C2	Makes me feel I have the ability to succeed
C1	Helps me feel confident that I can do well
A4	Shows how the content relates to things I already know
C3	Builds my self-esteem

Factor 2 (Relevance plus)

R7	Personal benefits of the course are made clear to me
A9	Curiosity is often stimulated
C8	Helps me to believe I can succeed if I try hard enough
R8	Challenge level is about right

Factor 3 (Relaxed)

C11	Non-threatening
C12	Designed so that everyone can succeed

Factor 4

C10	Instructor models and demonstrates proper skills
R11	Content relates to my expectations and goals
A8	Uses an interesting variety of teaching techniques

Factor 5 (Success)

C6	Requirements for success are made clear to me
C7	Frequent opportunities to succeed

Factor 6

R10	Get a chance to work with other people
A7	Does unusual or surprising things that are interesting

Factor 7

R2	Allows time for practical application of the content
A6	Makes me feel curious about the subject matter

Title:

The Effects of Course Structure on Students' Computer Attitudes

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The Effects of Course Structure on Students' Computer Attitudes

This study investigated the effects of course structure variables on the computer anxiety, confidence, and attitudes of college students. These course structure variables included the number of weeks the course met (course length) and number of meetings per week (course frequency). The effects of differences in instructors' use of anxiety reducing strategies as reported by the students were controlled by statistical analyses. Differences in course structure only had significant effects on students' computer anxiety. Students in courses that met more times per week and for a longer time period had their computer anxiety reduced to a greater extent. Computer confidence and attitudes were not differentially affected.

Anxiety toward computers can be a tremendous problem for individuals, especially teachers, in a society that is rapidly becoming more technological. Sanders and Stone (1986) identify societal and occupational consequences of computer deficiencies in our country. These results of computer avoidance have an adverse effect on our society as it becomes more dependent upon computers and other technological innovations. They emphasize the importance of improving computer skills and attitudes for all learners. Raub (1981) surveyed college students regarding their attitudes toward computers and reported that fear or anxiety about computers led to negative attitudes toward their use. Badagliacco (1990) and Howard, Murphy, and Thomas (1987) state that the issue of feelings of anxiety and of alienation toward computers is sufficiently important that intensive study is needed. We should learn more about the nature of computer anxiety so that we might better prescribe effective interventions for learners.

In order to gain a better understanding of the nature of computer anxiety and confidence it is important to investigate their interaction with instruction (Bohlin, 1990). This study was designed to investigate the effects of different course structures on the attitudes of students by investigating student perceptions of the computer instruction and changes in their computer anxiety and confidence scores.

COMPUTER ATTITUDES

Computer anxiety can be viewed as a form of state anxiety associated with computer use (Cambre & Cook, 1985; Howard, 1984). Computer anxiety has been defined as "the fear or apprehension felt by individuals when they used computers, or when they considered the possibility of computer utilization" (Simonson, Mauer, Torardi, and Whitaker, 1987, p. 238).

Studies (Hunt & Bohlin, in press; and Loyd, Loyd, &Gressard, 1987) have found a strong relationship between computer confidence and computer anxiety. This relationship is believed to be based in the cognitive link between expectancy for success with computers and diminished fear of interacting with them. A learner who feels anxious is less likely to be confident of performance.

Conversely, a computer-confident learner is less likely to feel anxiety about using or learning on a computer. Several studies have reported significant correlates to computer anxiety. However none has looked at changes in computer anxiety and confidence as related to specific instructional structure. Loyd &Gressard (1987) have found a relationship between computer confidence and anxiety and usefulness and liking of computers. Because one goal of a computer class in Teacher Education is to facilitate the later integration of computers into the teachers' curriculum, this study also investigated the impact on all four variables.

Because anxiety interferes with encoding and retrieval of learned information, it is expected that increasing the frequency of meetings in a computer class would have a greater impact on the learners' computer confidence, which in turn would have a greater influence on their anxiety. Also, it is expected that increasing the length of a computer class would have a greater impact on the learners' computer anxiety and confidence. This study examined the effects of both.

METHODOLOGY

The study was conducted during the Spring, Summer, and Fall 1991 semesters, using over 15 different sections of a course required for state teaching credentials. The subjects, ranging in age from 20 to 57 years of age (mean = 31.9), were 381 undergraduate, post-baccalaureate, and graduate students at two campuses of a very large western state university. The sample included 71 males, 292 females, and 18 "no response" pre- and in-service teachers. They were given the instruments during their first or second lecture meeting of the term and again during the last week of classes.

The following tests were selected as measures of the variables investigated in this study. Computer anxiety, computer confidence, usefulness of computers, and liking of computers were measured using the appropriate subscales of the Computer Attitude Scale (CAS), developed by Loyd & Gressard. The instrument was validated by judges ratings and an factor analysis of the ratings of 155 subjects, and the subscales of the instrument have a coefficient alpha reliability ranging from 0.76 to 0.89 (Loyd and Gressard, 1984).

Because the teachers' instructional strategies can also have an impact on the affect of the learners, analyses controlled for the rate of use of nine specific anxiety-reducing teacher behaviors. Data for this variable were obtained by subjects' recall. Students were asked to report the frequency (5-level Likert scale) with which their instructor used the nine identified strategies. These anxiety-reducing strategies studied as a variable in this study included the following:

- Showing the insides of a computer or peripheral
- Modeling computer skills
- Encouraging students to learn on the computer by trial & error
- Providing for hands-on computer experiences in class
- Having students work in pairs or small groups
- Providing role models to show that computers are not just a white male domain
- Assuring learners that it is alright to make mistakes on a computer
- Explaining that learners are really in control of the computer

Information regarding the age and sex of the subjects was also obtained. Sections were coded according to the length of the course (greater than or less than 11 weeks) and to the number of sessions per week (once or more than once).

Multiple analysis of variance on repeated measures were performed with the four dependent variables of computer anxiety, computer confidence, usefulness of computers, and liking of computers scores and with the two independent variables of course length (long and short course) and the frequency of meeting (high and low frequency), and the three covariates of instructor behavior (high and low frequency of anxiety reducing behaviors), age (high and low), and sex (male and female).

Subjects were directed to code all of their responses on scanable forms. Their responses were electronically scanned and all analyses were performed using SPSS-PC on an IBM-compatable AT computer.

RESULTS

The Multiple Analyses of Variance found that changes in computer anxiety differed significantly for frequency of meeting ($F_{1,391} = 8.86, p < .005$), for course length ($F_{1,391} = 3.94, p < .05$), and for frequency of meeting X course length ($F_{1,391} = 5.08, p < .05$). Students in high frequency courses (that met more than once per week) and long courses (that met for greater than eight weeks) had a greater reduction in their anxiety towards computers.

The Multiple Analyses of Variance on differences of changes in students' computer confidence, perceptions of usefulness of computers, and liking of computers by course structure were found to be not significant.

DISCUSSION

These results suggest that for these teachers and pre-service teachers the frequency of instructional meetings per week and the period of time over which the instruction occurs can have an important impact on the learners' post-course computer anxiety.

For these subjects, however, frequency of meeting and length of course (within these limits) do not appear to have a significantly different effect on the students' computer confidence, perceptions of computer usefulness, and liking of computers. This is somewhat surprising in several ways.

The mechanism for the effects of high frequency classes lessening the anxiety is typically expected to be through improved confidence. In working with the computers regularly with short time periods between lessons, the students do not have to recall procedures over long time periods such as one week. Because anxiety interfers with memory (both encoding and recall), structures in the course that allow for easier recall or encoding would improve an anxious learner's confidence. Greater confidence and less frustration in forgetting previously learned procedures would be expected to reduce anxiety to a greater extent. These results suggest that the level and rate of frustration during instruction may be a stronger intervening variable for changes in computer anxiety than those investigated. It also might be important to investigate the degree to which instructors assist their students' memory of important skills.

In spite of the lack of significance of length of course on three of the variables, one would expect that instructional interventions over a longer period of time would have a greater effect on attitudes and confidence. Affective shifts seem to require a relatively period of long time to occur. It is possible that changes in computer confidence may be more closely related to total time working with computers and less with these variables. Because of the nature of this course, all sections meet about the same amount of total time. Therefore, total instructional time was not investigated as a variable in this study.

IMPLICATIONS

If a reduction in computer anxiety is an important consideration in the design of a course and/or training for a similar type of student, the instruction should be planned so that it meets frequently during the week and so that the formal learning takes place over a period of more than eleven weeks. These results suggest that the typical summer school course or short-term workshop should not be used when working with in- and pre-service teachers, if they have computer anxiety. These results also suggest that even quarter computer courses, usually ten weeks in length, may not be adequate for learners with relatively high anxiety.

Instructional strategies that reduce computer anxiety do not significantly affect confidence and attitudes toward computers. While there are strong correlations between these variables, they are in fact affected differentially. It, therefore, would seem to be important to continue to investigate at least all four of these variables when studying students and their affective perceptions of computers.

These results also suggest that the degree of frustration during learning may be an important intervening variable to changes in computer anxiety. It is recommended that this variable be included in future studies of interventions of computer anxiety.

It may be necessary to examine the rate of instructors' use of classroom methods of supporting students' memory during instruction, in order to more precisely measure differing effects of course structure. These strategies are different than the anxiety-reducing strategies investigated in this study.

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Title:

Networking on the Network: Teachers and Electronic Mail

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Networking on the Network: Teachers and Electronic Mail

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The new communication technologies of computer-mediated communication (CMC), including electronic messaging (commonly called E–mail), are now coming into the early stages of adoption in elementary and secondary schools. Initially computers were often adopted for instructional purposes, and now their instructional use is becoming extensive (Cuban, 1986). They are increasingly finding a new use: communication networking. (See McCarthy, 1989, for a discussion of student networking; West, Inghilleri, McSwiney, Sayers, & Stroud, 1989, for a technical report on an electronic network for teachers; and McAnge, 1990, for a directory of computer networks and networking projects for teachers.) As with many new electronic technologies, there is little if any argument that their eventual widespread use is inevitable (Huber, 1984), partly because within organizations, use of computers for one purpose encourages further computer use (Salem and Gratz, 1989).

Schools and computer communication

The school culture into which CMC is being introduced is one that faces numerous and profound difficulties of communication. Jackson (1968) found that many teachers had "a desire to draw more heavily than they presently do on the services of other specialists within the system--such as music and art teachers" (p. 133). Some social or institutional barrier against a greater degree of interchange and collegiality is implied by this desire--and its lack of fulfillment. Feiman-Nemser and Floden (1986) found that teacher isolation was a reality, and teachers' interactions seldom included discussions of work or collaborations on shared problems. Lortie (1975) described schools as having "separate cells" (p. 14) in which teachers worked, with "gaps in interpersonal support" (p. 73). Almost half (45 percent) of Lortie's respondents said they had no work-related contact with other teachers, and nearly a third (32 percent) had "some" (p. 193). Teachers spend inordinate amounts of time compartmentalized away from other adults, surrounded only by students (The Holmes Group, 1986; Sarason, 1982). Cusick (1981) noted that teachers were isolated in their classrooms and lacked common values regarding student behavior; he found that the schools had no force serving to build consensus.

Some of the above communication inadequacy would seem to be particularly susceptible to solution by electronic mail. E–mail is fast. Even relatively slow E–mail systems that "store and forward" messages, resulting in overnight delivery, are much faster than hard-copy personal letters and memos. E–mail is asynchronous, meaning it can function when communicators are separated by distance and are not attending to the exchange at the same time (Rogers, 1988), unlike other rapid forms of electronic media such as the telephone. Computer networks have already had demonstrable effects on business, including encouraging communication between individuals who are in dispersed locations; they have the general effect of overcoming the limitations of time, spatial distance, and interaction with the organizational hierarchy with which communication media must deal (Rogers, 1988). Taylor (1986) theorized that CMC would encourage horizontal contacts (those outside the normal superior-subordinate relationship within departments), and would fundamentally challenge and change organizational structure, creating a freer, less hierarchical organizational structure. Communication mechanisms such as electronic mail, which help overcome the logistical difficulty of teacher interpersonal communication, may have a considerable impact on the overall type and quantity of communicating teachers do with each other.

Information potential of communication

Generally, people who are homophilous (belong to the same group, as in religion, ethnic background, profession or other categorical variable) have stronger relationships with each other than those who are heterophilous (not alike on the categorical variable of interest) (Granovetter, 1973; 1982). According to the theory of the "strength of weak ties," there is a price to be paid for having strong ties: They do not allow for as much transmission of innovative and novel ideas as weak ties (those between individuals who are less similar).

Granovetter argued that a person ("Ego") will have friends (to whom Ego relates closely) who are more likely to know each other well than are Ego's acquaintances (to whom Ego relates less closely) -- and therein may lie a type of social inbreeding of ideas. Ego's close friends form a relatively dense clump, but Ego's acquaintances probably have their own close friends, and thus their own dense clumps of social ties different from Ego's. People with few acquaintances, under the theory of the strength of weak ties, get less information and input from people other than their close friends, and thus may have a more provincial store of news and opinion to draw from (Granovetter, 1982).

Put in more formal terms, the strength of weak ties means there is a higher information-exchange potential in dyadic communication when the communicators are heterophilous (Rogers & Kincaid, 1981). People are more likely to find out something new and useful from someone who comes from a bit of a different background.

Within the world of education, then, contacts should be encouraged between teachers who come from different content areas, since contacts within content areas have less information potential than those that are cross-disciplinary. For example teachers in English or foreign languages should derive utility from ideas and methods used in science, methods they are unlikely to encounter without contact with science teachers. But teachers' personal communication networks, according to the above-cited literature, do little to encourage or accomplish much interchange at all, and Rohland (1985) found teachers interact most often with those who are nearby, and in the same teaching content discipline -- in other words, most relationships are homophilous in terms of teaching content area.

Research questions

Since adoption of electronic messaging has begun in schools, the time was ripe for a study of the uses to which early adopters put E-mail. Early adopters of new technology can play a very influential role in the ultimate uses to which the technology is put. The study looked for evidence that electronic mail encouraged contact between teachers in different content areas, indicating the potential for a change in the personal networking patterns of teachers that would ease the transmission of novel ideas and teaching approaches.

- Who were the early users of E-mail among teachers and how were they using it it?
- How did the amount of usage break down by teaching content area?
- How much messaging went on within and between content areas?

UNITE System

The system studied was UNITE, the Unified Network for Informatics in Teacher Education (UNITE) system at the Kansas University Instructional Technology Center, a computer-mediated communciation system involving hypertext. UNITE, at the time of this study, was operating in six school districts and

16 schools in eastern Kansas. In nearly all cases, there was one UNITE terminal in each school. Most of them were located in the school library, a department office, or some work area accessible to numerous teachers.

UNITE is written in HyperCard and has two major components: an electronic mail system, and what are called dynamic resources, which take the form of a hypertext shared database of administrative information, computer courseware, lesson plans, and research in a broad spectrum of academic content areas. The system's original design was primarily centered on making the dynamic resources available to teachers, and the electronic mail component was added to the system to make communication easier between users of the resources and between users and system developers.

Teachers can access information in the dynamic resources, add lesson plans and evaluations, and contribute abstracts of pertinent articles and research, but it is the electronic messaging system that is of interest to this study. Teachers can use the E–mail system to send one-to-one messages (identifying other specific individuals on the system), or one-to-many messages. One-to-many message senders may identify either the members of special interest groups (SIGs) (for example, Science Teachers or Message System Critics), or they may send a message "to all," which targets everyone who has a UNITE electronic mailbox.

It is important to note that, while the UNITE E–mail system was originally intended to play a subordinate role to the development of the dynamic resources, it took on a life of its own very early in system development, and many if not most of the messages posted (including general one-to-many and individual one-to-one messages) concerned topics divorced from dynamic resource development. This substantiated E–mail's ability to serve a need and fill a niche in educational communication.

A further important descriptive point about the UNITE environment: The communication that took place on the system was almost entirely ad hoc, since no formal structures or training for using the system were implemented. UNITE's graphical user interface was designed for ease of use (in stark contrast to most mainframe electronic mail systems such as run E–mail at most universities); technical support and training for new users was minimal, and many users simply logged themselves on, followed directions to establish their own password, and used the system on their own. Some support was clearly available from teachers who got involved in the project early on and encouraged others to join in, but that support was entirely informal and in many schools virtually nonexistent. Thus, electronic communication on UNITE was virtually unguided and uninfluenced by any particular networking strategy beyond a desire to provide an environment in which teachers could easily get E–mail messages to each other. (See Aust, 1991, April; and Aust and Klayder, 1990, February, for discussions and descriptions of UNITE by the system's developers.)

Method

A network analysis was conducted of one-to-one messaging on the UNITE E–mail system. A core of volunteers was recruited and their permission obtained to study to whom they sent messages and from whom they received them. The researcher was not given access to the actual content of the messages, but all volunteers answered a questionnaire that characterized their contacts as professional or social in nature. The who-to-whom messaging data were gathered electronically and unobtrusively from the hub of the UNITE system according to guidelines and procedures suggested by Danowski (1983).

The amount of messaging was measured; the emergent (informal) communication groups that formed on the system were identified using a computer program called NEGOPY (Richards & Rice, 1981), which has been recommended as a de facto standard for cluster analysis (Rogers & Kincaid, 1981). Where messages moved in only one direction, resulting in an unreciprocated communication relationship, the program dropped links to force reciprocation. The messaging within and between teaching content areas was compared using chi-squares with links formed as dependent variable.

Finally, subjects in the study filled out a questionnaire that included closed-ended items about user demographics, computer literacy, and access to the system, along with open-ended items concerning why they used the system and what they got out of it. These responses were analyzed somewhat informally, but produced some useful information in light of the communication structures identified by the network analysis.

Results

Sixty-five UNITE system users agreed to participate in the study; 42 of them (65%) used the E-mail system either to send or receive one-to-one messages; 32 (49%) were message senders.

Content areas: The largest group of E-mail-using teachers was the science teachers (15 or 36%), with a substantial contingent of librarians and educational communication specialists (10 or 24%); there were also university/adult education teachers (6 or 14%), general elementary teachers (5 or 12%), and 6 (14%) miscellaneous others.

Messaging sending: Easily the most avid users of the E-mail system were the librarians. They corresponded on the system with more individuals than non-librarians (an average of 4.8 links per librarian, compared to 2.5 for all other E-mail users) and sent more messages (an average of 56.6 compared to 8.5).

Those who had a UNITE terminal on their desk, in the same room, or in a nearby room (n = 21) sent significantly more messages than those for whom the terminal was not so close (n = 21) (Mann-Whitney test, U = 145.0, W = 376.0, Z = 1.9212, $p < .05$).

Cluster analysis: Two groups of ad-hoc communicators emerged on the UNITE E-mail system. The larger group was fairly heterogeneous while the smaller was entirely made up of librarians.

GROUP ONE (N=14)		GROUP TWO (N = 5)	
Science	5	Library/Ed Comm	5
University/Adult	4		
Gen'l Elementary	3		
Library/Ed Comm	1		
Other	1		

Crosstabulation: A content-area by content-area chi-square of links formed found that teaching content area was a significant constraint on communication. The chi-square value (124.47, df = 30) was significant at the $p < .01$ level. The adjusted residuals for the cells denoting communication by librarians with librarians, and elementary teachers with elementary teachers, were significant at the $p < .05$ level. In other words, librarians formed more links with librarians and elementary teachers formed more links with elementary teachers than would be predicted by chance.

Discussion

Message sending, the emergence of informal groups, and communication between members of pre-existent groups all indicate that librarians were at the center of electronic messaging on the UNITE system, and most communication occurred between teachers who came from the same teaching content area. This study does not provide evidence that the communication networks teachers form on an electronic mail system will differ significantly from teachers' face-to-face communication networks, both being dominated by contacts with other teachers in the same content area. Networking itself did not appear to encourage an increased volume and richness of information flow between teaching content areas. To accomplish that goal, deeper, underlying strategies to encourage cross-disciplinary communication appear to be needed.

As a basis for future studies to establish appropriate strategies for improving the educational communication process, it is useful to look at three factors that emerged from the network analysis and from teachers' responses to open-ended questions about their use of the UNITE E-mail system.

Time: From open-ended responses to the questionnaire, it was apparent that constraints on teachers' time put constraints on their use of the system, even though the system's dynamic resources component is designed to save teachers time and effort in the long run. Overall, teachers and librarians expressed frustration with the lack of time they had to take care of their normal duties, let alone familiarize themselves with the computer system. Many simply did not see what they would get in return for time and effort invested in using UNITE. Librarians have greater leeway in how they structure their time, with less of it devoted to direct, disciplinary supervision of classes, and thus were better able to devote attention to UNITE than were classroom teachers. This, in part, explains the higher levels of use of the E-mail system by librarians than other teachers. They simply had more time available for attending to it.

Accessibility: This study was consistent with other research that showed that the physical accessibility of a terminal is a major determinant in who will use it (West, Inghilleri, McSwiney, Sayers, & Stroud 1989; Steinfield, 1986). The farther away the terminal, the fewer the overt opportunities to use it, and in some broader sense the less the encouragement to use it. The placement of shared hardware and resources such as UNITE terminals is clearly a major issue in designing instructional support systems.

Librarians again benefited from the way UNITE was implemented in the schools. Many UNITE terminals were located in school libraries as a compromise to allow as many teachers as possible to get relatively equal access, and a few others were located in departmental offices or elsewhere in the school building.

Routine: A clear factor indicated by librarians' responses to open-ended questions was the degree to which networking on UNITE fit easily into their daily routines, above and beyond the above-mentioned factors of time and accessibility. Several librarians (and other teachers) pointed out that librarians normally keep in touch with other librarians on a fairly regular basis to help locate and share instructional materials. The most common example was phoning around to locate books to request for interlibrary loan. Much of this activity translated directly to E-mail; E-mail probably encouraged an increase in communication in general among librarians because they were already in the habit of networking and UNITE gave them another mechanism for doing it. Librarians were among the early users of UNITE and some of them were the system's biggest boosters.

For other teachers, electronic mail did not fit into the daily routine with the same ease. While nearly all of the teachers who participated in this study were computer literate, hardly any of them indicated that they used computers for word processing, figuring grades, or other daily instructional management tasks. They had no computer on their desk. UNITE represented a form of computer that was "over there somewhere," not part of what they normally did to prepare lessons. The daily routine does not yet include the use of computers for familiar tasks, so the use of computers for relatively novel tasks remains unexplored. One of those unexplored tasks is the use of computer-mediated communication for expanding teachers' personal networks beyond their usual spheres to include contacts from varying disciplines with potentially novel approaches to instructional tasks and problems.

In some way all three factors -- time, accessibility, and routine -- discouraged adoption of computer-mediated communication by teachers in general at the time of this study, while at the same time the use of the system by librarians demonstrated its promise and usefulness. At such time as teachers do become routinely familiar with computer use, electronic mail could play an expanding role in educational communication, and it may well yet encourage communication between teachers in different teaching content areas, creating a genuinely new and optimally useful set of professional contacts. But the introduction of computers for E-mail and other electornic communication in schools by itself may be insufficient to encourage cross-disciplinary communication. Specific strategies should be carefully considered prior to implementation of any electronic mail or other CMC system for it to reach its full potential in enriching the communication environment of the school.

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Title:

Conducting Qualitative Research in Instructional Technology: Methods and Techniques

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Conducting Qualitative Research in Instructional Technology: Methods and Techniques

Various philosophical orientations to interpretive research are categorized under the umbrella term qualitative research. For example, ethnography, phenomenology, interpretive research, symbolic interactionism, and ecological psychology, to identify a few categories, are all orientations of qualitative research (Glesne & Peshkin, 1992). All forms of qualitative research share common characteristics and research methods. It is beyond the scope of this paper to discuss all categories of qualitative research. The focus of this paper is to initiate the novice researcher to the case study and the use of ethnography and phenomenological methods and techniques of research.

Ethnography

Both ethnographic and phenomenological research are interpretive / descriptive forms of research. At the center of ethnographic research is the concept of culture (Tesch, 1988). Goetz and LeCompte (1984) describe ethnography as "analytic descriptions or reconstruction's of intact cultural scenes and groups" (p.2). The ethnographic investigation focuses upon the social organization of a group in order to examine cultural processes and perspectives of those within the culture. The meaning people give within a culture to their experiences is not accidental to the ethnographer. Rather, the meaning assigned to experiences and behaviors displayed by those in a culture, are the results of a complex mixture among objects, situations, and events.

Applying ethnographic research to education necessitates recognizing educational settings as cultural entities. Social scientists believe that human behavior is significantly influenced by the environment in which it occurs. Ecological psychologists claim that if one ultimately wants to generalize research findings to the everyday world, then the research must be conducted in the environment in which the behavior occurs and everyday forces are recognized. As Wilson observes, " The inability of classical learning theories to say very much that is meaningful about everyday classroom learning can be explained in part by the absence of these school/organizational forces in the research laboratories where the theories were developed (Wilson, 1977, p. 248).

Ethnographic design requires investigative strategies which enable cultural reconstruction. Ethnographic strategies are empirical and naturalistic. Participant and non participant observation are used to obtain firsthand, sensory accounts of phenomena as they occur in natural settings. In addition, strategies are used to elicit phenomenological data, which represent the view of the participants being investigated. Characteristics of classical educational ethnography strategies include:

> ". . .the investigation of a small, relatively homogeneous and geographically bounded study site . . . long term and repeated residence of the researcher at the site . . . use of participant observation as the preferred data collection strategy, supplemented with a variety of ancillary techniques . . . a data base consisting primarily of field notes . . . and . . . a preoccupation and explanation of the culture, life ways, and social structure of the group under investigation. . . (Goetz and LeCompte, 1984, p. 17)".

Phenomenology

At the center of phenomenological research is the human experience of an occurrence. Phenomenology asks the question, what makes something what it is

(Van Maanen, 1990). Phenomenological researchers believe that there are multiple ways of interpreting events for each person, and that a person's interpretation is what constitutes reality for that person (Bogdan & Biklen, 1982). What distinguishes phenomenology from other qualitative research approaches is that the "subjective experience is at the center of the inquiry" (Tesch, 1988, p. 2).

The phenomenological research tradition relies on two assumptions: That the perceptions of the person being interviewed are valid; and that the experience and background of the researcher are sufficient to analyze the findings in a scholarly and responsible manner. Phenomenological researchers depend almost exclusively on in-depth interviews as their main investigative strategies, using observation only where verbalization is inadequate (Tesch, 1988).

Phenomenology does not rely on the "thick or rich" data that is generally associated with the ethnographic study. Instead, data are collected from the experiences of the participant and derive meaning, because of and in conjunction with, the background and experience of the researcher. Van Maanen (1990) connects the characteristics of thoughtfulness and love to the interview process. These characteristics enable the researcher to understand how the participant lived the experience that is being described. The researcher and the participant come to an understanding of the experience. Tesch (1988) describes the phenomenological interview as "dialogical reflection" rather than a set of questions and answers. Participants are encouraged to reiterate and express themselves in different ways, in an attempt to provide the researcher with an understanding of what constitutes the participants' reality of an event or interaction.

Case Study

There is little agreement as to the exact definition of a case study. Case studies provide a holistic description of an environment. They convey to the reader a sense of being there, or a vicarious experience. Lincoln and Guba (1985) propose that case studies may be composed for different purposes and written at different analytical levels. Their suggestions of categories for case studies and brief definitions of the categories are as follows: (1) chronicle (to record temporally); (2) render (to provide vicarious experience); (3) teach (as providing instructional materials); and (4) test (to test certain theories and hypotheses in a setting). However, it is recognized that any case may serve multiple purposes and fit under more than one category.

Depending on the purpose of the case study, Lincoln and Guba propose the study may be written at different analytical levels, and depending on purpose of the study, result in different products. The analytical levels they recognize include, " a merely factual level, an interpretative level, and an evaluative level (Lincoln and Guba 1985, p. 361)". Due to the evolving nature of a naturalistic study, they suggest that most naturalistic researchers will want to chronicle and render at the factual level, engage in interpretation for research and engage in evaluation for policy analysis.

Research Questions

The research questions in a qualitative study may be vague at the onset of the study. Performing a pilot study helps the researcher clarify the research questions. It provides an opportunity for the researcher to explore the setting, clarify questions and learn how to be a part of the setting (Glesne & Peshkin, 1992). Additionally, a thorough acquaintance with the related research and theory helps the researcher to focus the original research questions (Wilson, 1977).

Research objectives formulated from the research questions can help guide the data collection, however, the researcher remains free to explore new areas or other areas as they arise out of the researchers observations. The qualitative researcher is always aware that new information may change the research questions or create a new question. Once in the setting it may become apparent that the initial research questions are insufficient or inappropriate, resulting in new questions and direction of the study.

Population

Purposeful selection best describes the selection of participants in a qualitative study. Participants are identified and selected by their behaviors and beliefs, as interpreted by the researcher, as to their relevance in exploring the research questions. It is impossible for the researcher to know, at the onset of the study, all of those who will eventually become participants in the study. Identification of participants evolves as does the study (Glesne & Peshkin, 1992; Lincoln & Guba, 1985).

Data Collection and Analysis

Rich data collected from the research setting provides an illuminating understanding of classroom events and generates additional ideas and questions concerning teachers and technology (Shoenfield & Verban,1988). The instrument for data collection in ethnography and phenomenological research is the human being. The goal of the researcher is to understand the research setting, the participants and their behavior. The researcher recognizes that it is not enough to simply be aware of the framework within which human behaviors occur, but, that there must be a systematic effort to develop an understanding of the context in which the behaviors occur.

Data collection techniques include interview, observation, document and record analysis, and nonverbal cues (Lincoln & Guba, 1985). The researcher makes calculated decisions as to what kind of data to collect and whether active probing rather than simple naturalistic observation should be used (Wilson, 1977). For example, the researcher may observe an interaction between two students and interpret the interaction based on previous observations and knowledge of the situation. Or, the researcher may not feel that a true interpretation of the event may be made without further probing and decides to interview the participants to gain a better understanding of the incident.

Handwritten field notes are a common method of recording the researcher's observations and serve to keep the researcher attentive. While other means of recording observations are available, such as the camcorder or tape recorder, the researcher must be aware of the potential of these devices to influence the research setting. Participants may not be as open to the researcher if they feel threatened by a permanent recording (Lincoln & Guba, 1985).

Field notes consist of detailed descriptions of the setting, events, and interactions of participants. They also provide a place to record the researcher's ideas, reflections and interpretations of the observed events. Notes written in the field may initially be only a few hastily written words to help the researcher remember exact descriptions, that will later be expanded; or they may be full detailed descriptions of the event (Glesne & Peshkin, 1992).

The format of field notes is dependent upon the individual preferences of the researcher. Some researchers prefer loose leaf notebooks or index cards to record observations. This enables the researcher to organize observations into categories as the study progresses rather than waiting until the end of data collection to begin categorizing. Other researcher prefer to record their observations in spiral notebooks and later transcribe them to computer files. Researchers follow various methods of coding and organizing their field notes. Coding may be according to chronological order, such as historical information and events, or follow themes that have emerged during the collection process.

Documents provide additional sources of data for the researcher. Lincoln and Guba (1985), suggest the following reasons for the inclusion of documents as a data resource: (1) availability and low cost; (2) a stable source of information which can be analyzed and re analyzed; (3) they are contextually relevant and written in the natural language of the setting; (4) they are often statements that satisfy some accountability requirement; and (5) they are non reactive, unlike human respondents. However, they also caution that records can be in error, either intentionally or unintentionally.

Additional sources which have the potential to provide a rich source of data are informants and found pictures. Informants may play a variety of roles in the research setting and are invaluable to the researcher in a closed community. Their membership in the researched group who may allow them to direct the researcher to unexplored data resources, provide introductions to key members of the group, or even collaborate with the researcher throughout all phases of the study (Glesne & Peshkin, 1992).

Pictures, either still or motion, can provide in depth detail about a setting or event. However, care should be taken in interpreting the events depicted in a picture. Pictures found without accompanying dialogue may be misinterpreted. Additionally, photography and filming techniques can be used to cast an event in a particular mode.

The length of time in the field interacts with the conceptual perspective the researcher takes. For example, the process of time or what happened in the setting during a specific frame of time may be of specific interest to the researcher. In the school setting the period of time of a study may be a semester, school year, grading period, the length of a project (Smith, 1979). Observations of the setting should not be limited to one specific day of the week or time of day, during the study. They should be made at various times throughout the study in relation to events. For example, the activities in a school setting will not be the same on the day before a school holiday as the day before the administering of a national test.

Triangulation improves the probability that interpretations of data will be credible. This practice involves the incorporation of multiple data sources, methods, investigators and theoretical perspectives in the study (Glesne & Peshkin, 1992; Lincoln & Guba, 1985).

Data analysis is the researcher's attempt to derive meaning or information from the data collected. Data collection and data analysis performed simultaneously enables the researcher to focus and direct the study. Glesne and Peshkin (1992) emphasize that analysis is a continuing process, rather than a specific stage, that should commence as soon as the study begins.

There are various strategies for analyzing data. Most researchers find it useful to look for themes, strands, incidents and commonalties in the data as it is collected. Developing metaphors and analogies may help the researcher analyze the data. To equate a situation to another situation, may help the researcher develop an awareness that would not have been apparent otherwise (Bogdan & Biklen, 1982). For example, institutional relationships between various divisions at a southwestern university were compared to a marriage separation by Cashman (1992) and helped to provide the researcher with understanding in a complex situation.

Reporting Results

In writing the results it is important to consider all interactions between subjects, objects, environment, culture, and belief system. Additionally, prior experiences and theoretical orientation of the researcher should be addressed.

Van Maanen (1988) recognizes three different types of styles or tales as forms of reporting ethnographic research: realist, confessional, and impressionist. The first style is the realist tale, in which the author takes an omnipotent view. In this style the author is concerned with the minute details of the participants' lives. These details are presented in an authoritarian style that seems to declare the authors' viewpoint as the reality.

The second style, is the confessional tale in which the author is present throughout the text. In the confessional tale authors recognize themselves as human beings who are prone to mistakes, but eventually arrive at a new understanding.

The third style, is the impressionist tale which makes use of dramatic recall in which the reader experiences vicariously the experiences of the researcher in the field. Rather than events being interpreted by the researcher, the readers derive their own interpretations. Impressionist tales, according to Van Maanen, "are not about what usually happens but about what rarely happens. These are the tales that presumably mark and make memorable the fieldwork experience" (Van Maanen 1988, p. 102).

Even though these styles of reporting are derived from ethnographic writing, they are styles that can be utilized in various areas of qualitative writing. It is the decision of the researcher to decide which reporting style or combination of styles will best represent the study. Additionally, it is recognized that qualitative reporting is not constrained by rules of style, but, is enhanced by the freedom allowed the researcher to determine the best format of reporting.

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Title:

Learning From Video: The Influence of Preconceptions on Invested Mental Effort

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Learning from video: The influence of preconceptions on invested mental effort

The fact that those who frequently watch television are referred to as "couch potatoes" indicates that American society accepts, and in fact expects, viewers to adopt a passive stance toward television viewing. Although a passive response to television may be beneficial when the goal of the individual is relaxation, the viewers' preconceptions of television as an easy, passive medium may interfere with their learning from the medium, and thus be detrimental to the use of television and videotapes for instruction.

In an often-cited study, Salomon (1984) measured learners' preconceptions of the ease or difficulty of print and television, then the learners received either a print-based or video-based lesson. Upon completion of the lesson, learners completed a questionnaire on the amount of mental effort that they perceived they invested in the learning task, and then were given an achievement test. Salomon found that students rated television as easier than print. Learners in the print condition reported investing more mental effort and had higher achievement scores than students who received the video lesson. Salomon concluded that the learners' preconceptions of television as an easy medium influenced the mental effort expended in processing the television lesson.

In Kozma's (1991) review of the literature on learning with media, he points to gaps in the research on learning from television and implies the need for the development of a theoretical model of television learning. As an initial step in the process, and toward that end, this paper explores the theoretical and research basis for the relationship between learners' preconceptions of television and the amount of mental effort invested in learning from a video-based lesson.

Salomon (1983) defines the construct of "mental effort " as the "number of non-automatic elaborations applied to a unit of material" (p. 42). The conscious, purposeful processing that results from increased mental effort is assumed to create greater activation of the learner's mental schemata. According to information processing theory, a schema is an organized network of knowledge that includes concepts, facts, skills, and action sequences organized in such a way that the individual elements can be stored and retrieved in terms of a more inclusive concept (Gagné & Glaser, 1987). As new information is received, the new information cues the retrieval of related prior knowledge stored in the learner's schemata. Through the process of elaboration, the learner makes connections between the new information and information retrieved from prior knowledge (E. Gagné, 1985). The increased contact with the learner's mental schemata that results from the conscious, non-automatic generation of elaborations, or mental effort, is presumed to facilitate the retention and retrieval of the new material. In contrast to automatic processing that is fast and effortless, non-automatic processing is deliberate, conscious, and very much under the control of the individual. Salomon's (1983b; 1984; Salomon & Leigh, 1984) findings of a significantly correlation between the amount of mental effort learners reported investing in a lesson and learners' preconceptions of the medium of presentation suggest that preconceptions of the processing requirements of video may influence the actual mental effort expended in learning from a video-based lesson.

This paper presents a model of the influence of learners' preconceptions on the amount of mental effort invested in learning from television. The proposed model suggests that learners' preconceptions are influenced by the characteristics of the media, the characteristics of the task, and the characteristics of the learner. The following sections will review the theoretical and research basis of these proposed relationships, present the practical implications of the current evidence in the area, and suggest an agenda for further research.

Insert Figure 1 about here

Preconceptions of Media

Weiner (1985) proposed that learners' perceptions of the ease or difficulty of learning from a particular medium may influence the amount of effort invested in the learning task. Weiner contended that individuals engage in tasks in order to gain information about their ability. Individuals seem to work best at tasks of intermediate difficulty because engaging in difficult tasks provides little information about their ability and may be perceived as a waste of effort, while easy tasks also provide little information about their ability and are perceived as unnecessary for success. When faced with tasks that learners perceive to be of intermediate difficulty, some individuals may exert a maximum of effort. This theory may account for Salomon's (1983b; 1984; Salomon & Leigh, 1984) findings that learners reported investing less mental effort in learning from a video-based lesson that was perceived as easy than from a print-based lesson that was perceived as more difficult (than the video-based lesson).

The results of Salomon and Leigh's (1984) investigation of the responses of high and low ability students to a television and print lesson lends credence to the idea that preconceptions of the effort required to process a lesson influence the actual effort expended in learning from the lesson. Salomon and Leigh presented learners with a television and print version of a story. Consistent with earlier findings, they found that the amount of mental effort reported by the TV group was significantly lower than that reported by the print group. In addition, high-ability students reported investing significantly less effort than the low-ability students in processing the televised story. Correspondingly, the high-ability students who viewed the televised version recalled significantly less than the low-ability students who viewed the same TV story and significantly less than the high-ability students that were exposed to the print version. Weiner's theory suggests that the low-ability students may have perceived the task of learning from television as of intermediate difficulty and thus exerted a maximum of effort, while those of high-ability may have perceived the televised lesson as too easy to provide them with additional information about their ability. Weiner's theory suggests that if learners can come to view television as worthy of the exertion of additional mental effort, or moderately difficult, then they will exert a maximum of effort.

Researchers who have investigated the nature of learners' preconceptions of video-based materials have questioned them on the perceived ease or difficulty of learning from several forms of media, the amount of effort they usually invest in processing mediated materials, their media preferences, and their perceptions of the potential of various media for facilitating learning. Several researchers have concluded students in grades three though ten perceive television to be significantly "easier" than print (Krendl, 1986; Salomon, 1983b; 1984; Salomon & Leigh, 1984) and computers and writing (Krendl, 1986).

However, there is some evidence that learners' preconceptions of media vary with the age and experience of the learner. Using methodology that was similar to that used by Krendl (1986), Cambre (1991) found that the media preferences of inservice teachers differed from younger students: whereas teachers preferred reading and watching television to using a computer and writing, students in grades three through ten preferred television watching and using a computer to reading and writing. Bordeauz and Lange (1991) found that the amount of effort children reported investing in children's programs decreased as the age of the viewer increased. As children became older, they may have become more proficient in processing children's television programs and, thus, reported the need to invest less effort than younger children.

Using a questionnaire that was modeled after Salomon's (1983; 1984), Cennamo, Savenye and Smith (1991) also found evidence that age and experience may influence learners' preconceptions of the ease of learning from a medium. They examined the preconceptions of pre-service teachers regarding the ease of learning from several forms of video-based instruction. The data analysis indicated that television was perceived to be significantly more difficult than instructional television and interactive video, and instructional television was perceived to be significantly more difficult than interactive video. Although these results were surprising in light of previous findings regarding the perceived ease of television viewing, the past academic successes of the learners and their major area of study may have provided the preservice teachers with greater insight into the learning process than the younger students who participated in earlier studies.

Kunkel and Kovaric (1983) provided evidence that learners may have different preconceptions of educational materials than they have of entertainment materials. College students reported investing significantly more mental effort in processing a television program that was designed for a Public Broadcasting Station (PBS) than in processing a program that was designed for a commercial television station. Kunkel and Kovaric reported that the majority of PBS programs are more serious and educational than commercial television programs, and the results of this study suggest that the students' perceptions of the effort required by the two types of programs may have been influenced by an awareness of this difference.

Several researchers suggest that the content of the television program may influence learners' perceptions of the effort required to process the program. Salomon (1983) questioned college students on the amount of mental effort generally expended on televised and printed adventure, sports, news, science, and crime stories. He found that, with the exception of the news, the estimated amount of invested mental effort was lower with television than with print. Using Salomon's questionnaire, Beentjes (1989) found that Dutch children did not always perceive it to be easier to learn from television than from books; instead, he found that students' ratings of the ease or difficulty of learning from a particular medium was strongly dependant on the topic in question. For example, the Dutch children perceived that it was easier to learn soccer rules from television than from a book, but felt that it was easier to learn to solve math problems from a book than from television.

Cennamo (1992) investigated learners' preconceptions of the ease of achieving various learning outcomes (psychomotor, affective, verbal, intellectual) through the media of interactive video, computers, television and books. The results indicated that there was a strong interaction between the presentation medium and the domain of the target learning outcome. Like the sixth-grade Dutch students who participated in Beentjes's (1989) study, the undergraduate students who participated in this study did not perceive it to be consistently easier to learn from television than from books. Although television was rated as easier than books for learning psychomotor skills and attitudes, books were rated as the easier medium for learning intellectual skills and verbal information. The overall means for television and computers suggested that they were perceived as very similar in ease of learning; however, an examination of the individual means for each domain indicated that television and computers were believed to facilitate the ease of learning very different types of skills. Whereas students perceived it to be easier to learn attitudes and psychomotor skills from television, they perceived it to be easier to learn intellectual skills and verbal information from computers.

In general, research on learners' preconceptions of television and video indicates that learners perceive television as an easy medium, they feel it requires little mental effort, and they believe they would learn little from a video-based lesson. However, learners' preconceptions of media may change as they become more experienced. Learners' preconceptions of the ease of learning from television also may vary depending on the content presented through the medium.

Mental Effort

Several researchers (Britton, Muth, & Glynn, 1986) have noted that the terms mental effort, attention, concentration, use of cognitive capacity, and mental workload all refer to similar concepts and refer to an increase in the cognitive resources devoted to processing the stimulus. Methods of assessing mental effort and similar constructs fall into three main categories: opinion measures, dual tasks techniques, and physiological measures. Opinion measures encompass the variety of self-report measures used to assess mental effort. Opinion measures assume that the investment of effort is a voluntary process which is under the control of the individual, and as such, is available for introspection. Dual task techniques encompass a range of methods which assign the learner a primary task such as reading a passage, working a problem, or viewing a videotape, and also assign the learner a secondary task such as responding to a tone, finger tapping, or estimating a time internal. Dual task techniques assume that there is a limit to the learner's cognitive capacity, and when a great deal of cognitive capacity is consumed by the primary task, there will be less capacity left to devote to the secondary task. Dual task techniques assume that the differences between performance on a baseline measurement of the secondary task and performance under experimental conditions is an indication of the amount of effort expended on the primary task. Physiological measures are based on the assumption that there is a physiological response to increases in effort expenditure. The difference between a learner's baseline measurement of the physiological process and a measurement taken while the learner is performing some task is assumed to be reflective of the amount of effort the learner is investing in the task.

Researchers have investigated factors that contribute to the effort invested in video-based materials using a variety of assessment techniques and found that the amount of mental effort invested in a video-based lesson can be influenced by several motivational and cognitive factors. In a series of studies, Salomon (1983; 1984; Salomon & Leigh, 1984) used self-report questionnaires to assess the amount of mental effort that learners perceived they had invested in processing television and print-based lessons. He consistently found that students reported investing less effort in processing a video-taped version of a story than in processing a text-based version. In addition, students who were instructed to learn from the story reported investing more effort in processing the story than those who were instructed to read or view the story for fun (Krendl & Watkins, 1983; Salomon & Leigh, 1984). Salomon concluded that learners' preconceptions of the effort required by television and print and the perceived purpose of the task seemed to influence the effort invested in learning from the television or print-based lesson.

Several other studies suggest that the complexity of video-based materials may influence the effort expended in processing a lesson. The complexity of a video-based lesson may be caused by a) perceptual factors such as the simultaneous presentation of congruent or incongruent audio and video information or b) message-related factors such as the organization of the content.

Research suggests that simultaneously attending to auditory and visual information requires that cognitive resources be devoted to the process. Learners invest more effort in processing video-based materials that present information through both the auditory and visual channels than through either channel alone (Reeves, Thorson, & Schleuder, 1985). In addition, learners exert more effort in learning from materials that contain a high degree of correspondence between the information presented through the audio and video channels than they do in learning from materials in which there is little correspondence between the video and auditory information or in which there is only a thematic match between the two channels of information (Grimes, 1990).

Using a secondary task technique to assess mental effort, Reeves and Thorson (1986) found that cues occurring during a complex moment in a television commercial elicited longer reaction times than cues that occurred during less complex moments. Complexity involved both auditory elements such as the sentence syntax and visual elements such as pans, zooms, and movement within the scene. Likewise, Lang, Strickwerda, and Sumner (1991) found that learners used more mental effort in processing video cuts that were unrelated to the prior scene than in processing cuts which were related to the previous scene through visual elements or narration. The increases in effort expended during complex moments such as these may result from the need for learners to search their memories for appropriate schemata in which to store the new information. The memory search required to make sense of new information may account for the increases in effort documented by these researchers.

However, videotaped messages that contained a large number of complex elements produced _faster_ reaction times than messages that were less complex (Reeves & Thorson, 1986). These findings suggest that learners expend more mental effort in processing messages that are simple, overall, than in processing complex messages. The researchers suggest that when processing complex messages, the viewers may be unable to call upon appropriate schemata. Simple messages may allow the viewers to easily call upon appropriate schemata, and thus, to actively engage in the process of elaboration.

The influence on mental effort of the learners' ability to call upon appropriate schemata was investigated by Meadowcroft and Reeves (1989). They classified children into those with "high schema development" and "low schema development". Using a secondary task technique to determine the amount of cognitive resources invested in the task, these researchers presented children with cartoons in a jumbled or normal form. Children that appeared to have well developed schema exerted less effort in processing the content of the programs than those who had low levels of schema development. It is possible that children with high schema development were able to call upon an appropriate schema more readily and to fill gaps in their schemata more effectively than those with less well developed schemata. The effect of story structure was nonsignificant; however, all students allocated more effort in attending to information that was central to the story content than in processing other peripheral information. Meadowcroft and Reeves concluded that children in the high schema group allocated their cognitive resources strategically, investing more effort when attending to a scene when it was central to the story content that to scenes that were incidental to the story content.

Mental Effort and Achievement

The results of research on mental effort and achievement indicates that there may not be a linear relationship between learners' invested mental effort and their achievement scores. Under certain conditions, increased effort may result in increased achievement. Yet, under other conditions, increased effort does not result in achievement gains.

When additional resources need to be devoted to perceptual processing in order to "make sense" of the information, increased effort does not always result in increased achievement. For example, Reeves, Thorson, and Schleuder (1985) presented learners with a videotaped program under audio-only, video-only, or audio-video conditions and found that reaction times to a secondary task were significantly delayed for those who attended to the audio-video presentation. However, there were no significant differences in learners' achievement scores among the three groups.

In other studies, increases in mental effort may have been accounted for by the effort required to search long-term memory for appropriate schemata in which to store the new information and, thus, may not have resulted in increased achievement scores. Lang, Strickwerda, and Sumner (1991) found that learners exerted more effort in processing video segments that included unrelated cuts representing changes in content than they did in processing segments that included related cuts linking information to new content through visual elements or narration. However, learners recalled more of the information surrounding related cuts than surrounding unrelated cuts. It is possible that when the learners were presented with an unrelated cut, they devoted additional cognitive resources to the search for relevant schemata in which to store the new information and, thus, missed the content necessary to perform well on a test of information surrounding the unrelated cuts.

Salomon (1983b) suggests that when a lesson is drastically inconsistent with learners' schemata, increased mental effort is not sufficient for increased achievement. He found that students who viewed a scrambled version of a videotaped program reported investing more mental effort in the program than students who viewed a normal version; however, they performed poorer than the students who viewed the normal program. Salomon's study (1983) suggests that simply expending more effort does not guarantee increased achievement when learners are unable to create a coherent mental model of the content. However, when Krendl and Watkins (1983) presented learners with a videotape which included irrelevant segments but retained the original narrative, learners attempted to assign meaning to extraneous scenes and to incorporate irrelevant information into the story line. In Krendl and Watkins' study, the availability of a main intact narrative apparently provided the structure necessary to tap into the viewer's schemata. In Salomon's study, self reports of increased mental effort indicated that the learners did attempt to elaborate on the material, but their lower performance suggests that they may have been unable to fit information into their existing schemata.

However, increased effort also has been shown to result in increased achievement. Grimes (1990) presented learners with three versions of a videotaped program and found that learners' reaction times to a secondary task were longest in the condition where the visual and auditory channels presented corresponding information (high correspondence), and shortest in the condition where there was only a thematic match between the visual and the audio portion of the program (medium correspondence). Scores on a visual recognition test followed the same pattern; learners who viewed the program with high correspondence scored highest and those who viewed the program with medium correspondence scored lowest. The presence of auditory and visual information with a high degree of correspondence may have provided the best conditions under which to elaborate on the content, thus explaining why learners who received this program achieved higher test scores.

Some researchers (Krendl & Watkins, 1983; Salomon, 1983b; Salomon, 1984; Salomon & Leigh, 1984) suggest that the benefits of increased mental effort may not be evident on a test of factual recall, but instead result in greater inferences. Holmes (1987) explains that "whereas factual recall involves understanding explicitly stated information, inferences require the reader to fill in missing information or to connect propositions in the text implied by the author" (p.14). Since Salomon (1981) defines mental effort as the number of "non-automatic elaborations" applied to a unit of material, and the inference process involves conscious elaborations of the material, it seems logical that inference questions may be a more sensitive measure of increased mental effort than recall or recognition tasks. Using self-report questionnaires, Salomon (1983b; 1984; Salomon & Leigh, 1984) and Cennamo, Savenye and Smith (1991) found a significant correlation between learners' reported mental effort and their scores on a test of inference items. Learners' who reported investing a large amount of mental effort received higher inference test scores than learners who reported investing less effort.

Influential Factors

The previous section described the proposed relationships among learners' preconceptions of the ease or difficulty of a medium, the amount of mental effort they invest in processing a lesson using that medium, and their resulting achievement scores. Given these relationships, the real questions remain: Why do learners perceive one medium as easier or more difficult than another for learning a particular lesson? What can be done to overcome learners' perceptions that television is an easy medium requiring very little investment of mental effort? What factors can influence learners to invest the optimum amount of mental effort in a learning task? And finally, how can we design more effective video-based materials?

In examining the literature to seek answers to these issues, several themes seem to emerge; factors which influence learners' preconceptions of the effort required by video-based materials and their actual or perceived mental effort expenditure seem to fall into the categories of characteristics of the media, characteristics of the task, and characteristics of the learners.

Characteristics of the Media

Several characteristics of video-based lessons have been shown to influence the amount of effort that learners perceive is needed and the actual effort invested in processing a video-based lesson. Several researchers have shown that the symbol systems employed by the medium influence effort (Reeves, Thorson, & Schleuder, 1985; Salomon, 1983b; Salomon, 1984; Salomon & Leigh, 1984). The perceptual complexity of the scene changes (Lang, Strickwerda, & Sumner, 1991; Reeves & Thorson, 1986) and the degree to which the audio and video elements are parallel (Grimes, 1990) may influence the effort required to search long-term memory for an appropriate schema and to elaborate on the content of the lesson. In addition, effort investment is influenced by the structure of the video-based lesson. The importance of a segment to the story line (Meadowcroft & Reeves, 1989) influences the way learners allocate their mental effort while processing a video-based lesson.

Characteristics of the Task

Several studies have varied the characteristics of the task in order to investigate the effects on learners' preconceptions of the effort required by video-based instruction and the amount of mental effort invested in such a task. Learners seem to exert more mental effort in a lesson from which they are told to learn than from a lesson they are told to view for fun (Krendl & Watkins, 1983; Salomon & Leigh, 1984). Likewise, learners report investing more mental effort in attending to educational television programs than in attending to commercial television programs (Kunkel & Kovaric, 1983). The domain of the desired learning outcome (Cennamo, 1992) and the topic of the lesson (Beentjes,1989) also seem to influence learners' preconceptions of the effort required by video-based instruction.

Characteristics of the Learner

The preconceptions that learners bring to an instructional situation regarding the amount of effort required by a video-based lesson and the actual amount of effort expended in processing the lesson are also influenced by individual characteristics of the learner. Research suggests that the age and experience of the learners may affect their media preferences (Cambre, 1991), the amount of effort they report investing in viewing a television program (Bordeaux & Lange, 1991), and the perceived ease of learning from a video-based lesson (Cennamo, Savenye, & Smith, 1991). In addition, there is other research which suggests learners' attitudes toward a medium might change as they gain more experience with that medium (Cambre, 1991; Cennamo, 1992). The amount of effort invested in a video-based lesson also may depend on the intellectual ability of the learner (Salomon & Leigh, 1984).

Summary

This paper has proposed a direct relationship between learners' preconceptions of the effort required to process a video-based lesson, the actual mental effort expended in processing the lesson, and learners' scores on achievement tests. It proposed that learners assess a learning situation in terms of the task at hand and the medium of presentation. They make a decision as to the ease or difficulty of the task based on their past experience with similar events. They decide to exert a certain amount of effort in processing the lesson. If characteristics of the lesson differ from those expected based on past experience (i. e. harder content, more complex visually) the learners reanalyze the situation and make "on-line" modifications of their effort expenditures. The amount of actual effort invested in the task may be influenced by cognitive activities such as perceptual processing, searching memory for appropriate schemata, or elaborating on the content. Increases in effort which result from the elaboration process may result in increased contact with the learners' mental schemata and facilitate retention and retrieval of the new material. There are several practical implications of the proposed model, yet, there are numerous questions which remain to be answered. The following sections will present practical suggestions which arise from research in this area and suggest areas for further study.

Practical implications

An awareness of factors which affect learners' preconceptions of video and the amount of mental effort invested in video-based materials can assist instructional designers in creating more effective video-based lessons. Techniques as simple as informing the users that the materials are designed to be educational (Kunkel & Kovaric, 1983) and they are to learn as much as possible from the lesson (Krendl & Watkins, 1983; Salomon & Leigh, 1984) should increase the effort invested in learning from a video-based lesson. In addition, designers should attempt to use the medium of presentation which is most appropriate for the domain of the target learning outcome (Cennamo, 1992).

The challenge for instructional designers is to maximize the effort that learners expend on elaborating the content, while minimizing the effort required to "make sense" of the content or to search long-term memory for an appropriate schemata in which to store the new material. The research suggests that the complexity of the message should be reduced through the use of simple syntax (Reeves & Thorson, 1986) and related cuts (Lang, et. al., 1991). The program should be designed so that there is a high degree of correspondence between the video and audio portions of the program (Grimes,1990). In addition, the intended message should be central to the story content (Meadowcroft & Reeves, 1989). Programs which provide pauses following complex elements such as unrelated scene changes, videographics, and complex sentences may provide time for the viewers to search their long-term memory for appropriate schemata before additional critical information is presented. Music, explanatory examples, and other mentally undemanding content may be used to allow the learners time to prepare to elaborate on new content information.

Although the instructional designer can not affect the age, experience, or ability of the learners, an awareness of such learner characteristics may assist the designer in creating a greater match between characteristics of the video-based materials and the learner. High-ability learners may need to perceive a video-based lesson as challenging in order to perceive it as necessary to gain information about their ability (Salomon & Leigh, 1984; Weiner, 1985).

Topics for Further Research

It has been suggested that learners' preconceptions of the effort required by a learning task are influenced by the characteristics of the media, characteristics of the task, and characteristics of the learner. These conclusions are based on learners' self-reports of their perceptions of media. Future research needs to examine the reasons why learners perceive one medium as easier or more difficult than another for learning a particular task. In-depth interviews with learners regarding the reasons why they may rate one medium as easier or more difficult than another may provide insight as to other factors which may influence their preconceptions of the effort required by a particular media-based lesson.

In addition, previous investigations of the amount of effort invested in a video-based lesson may have been limited by the methodology available to assess the construct of mental effort. Early work (Salomon, 1983; Salomon, 1984; Salomon & Leigh, 1984) used self-report questionnaires to document the learners' effort expenditures. Recently, however, researchers (Beentjes, 1989; Cennamo, et. al., 1991) have identified a need for more precise methods of assessing mental effort. Validation studies where mental effort is investigated using a variety of methods may yield the research tools necessary to explore other techniques which may increase the effort expended in processing video-based lessons.

A series of studies in human factors engineering (Casali & Wierwille, 1983; Wierwille & Connor, 1983; Wierwille, Rahimi, & Casali, 1985) have attempted to determine the sensitivity of 15 different assessment measures for detecting variations in the workload placed upon an operator of a flight simulator and may serve as a model for educational researchers investigating methods of assessing mental effort. The researchers found that the assessment measures which were most sensitive to manipulations in the operator workload varied depending on the type of task performed by the operator. For example, eyeblinks and eye fixation measures were sensitive to increases in the difficulty of a cognitive task, but were not sensitive to increases in the difficulty of a communication task. Although one of the opinion scales (Modified Cooper-Harper) and the time estimation task were sensitive to increases in operator demands across perceptual, psychomotor, communication, and cognitive problem solving tasks, the time estimation task resulted in an increase in the error rate of subjects who were performing the cognitive task. These results suggest that educational researchers who desire to assess the mental effort invested in learning tasks may need to take into consideration the type of task required of the learner and the possible interference effects of the assessment measures on the performance of the primary task.

Future research needs to continue investigating techniques that may be incorporated into video-based materials in order to increase the amount of effort invested in processing lessons presented through this medium. Due to the complexity of the symbol systems present in video-based instruction coupled with the linear, fixed pace of the presentation, it may be beneficial to include techniques that would assist the learner in actively processing the content in a more efficient manner. Techniques designed to facilitate the learners' search for appropriate schemata and to enhance their abilities to elaborate on the content may overcome the learners' potential conflict between attending to new information as it is being presented, conducting a memory search to activate appropriate schemata, or elaborating on the content. Techniques that cue the learners in advance as to the appropriate schema to engage or that allow the learners extra time to actively process new information may increase the mental effort that learners invest in processing a video-based lesson and, thus, increase the amount of information learned from the lesson.

Britton and his colleagues have varied the structure of text-based materials to determine the effects of various techniques on learners' invested mental effort. Using a secondary task method of assessing mental effort, they found that the amount of effort expended in reading text passages was influenced by the meaningfulness of the passage (Britton, Holdredge, Curry, & Westbrook, 1979), the learners prior knowledge of the content (Britton & Tesser,1982), the importance of the information (Britton, Muth, & Glynn, 1986), the style of writing (Britton, Graesser, Glynn, Hamilton, & Penland, 1983), embedded questions (Britton, Piha, Davis, & Wehausen, 1978), text syntax (Britton, Glynn, Meyer, & Penland, 1982) and the presence of objectives (Britton, Glynn, Muth, & Penland, 1985). It may be useful to incorporate similar techniques into video-based materials to determine if such factors influence the processing of text-based and video-based materials in a similar manner.

Future research also should investigate the effects of the enhanced processing capabilities offered by computers on learners' preconceptions and mental effort. The symbol systems available for books and television are very similar to those commonly available via computers and interactive video and it could be argued that interactive video and computer-based instruction are sophisticated variations of television and books with enhanced processing capabilities. Although many elaborate techniques for enhancing instruction are available through the addition of the computer, computer-aided instruction, at its most basic level, offers computer-controlled text and interactive video offers computer-controlled video.

Finally, the proposed link between learners' preconceptions of the effort required by a medium, the actual effort expended, and learners' achievement scores must be investigated in a systematic fashion. For example, the domain of the intended learning outcome seems to influence learners' perceptions of the ease of learning from a television lesson (Cennamo, 1992). Learners report that it is easier to learn psychomotor skills and attitudes from television than from books, but that it is easier to learn verbal information and intellectual skills from books than from television. In order to continue an investigation of the proposed relationships among learners' preconceptions, mental effort, and achievement, future research should investigate a) whether students actually invest more mental effort or learn more when instructed in psychomotor skills and attitudes through television than through print-based instruction, and b) whether learners invest more mental effort in learning psychomotor skills and attitudes from television than in learning verbal information and intellectual skills from television.

This review of the literature on preconceptions of video-based instruction and mental effort has also identified several areas in which there has been little research. Future research should investigate the influence of individuals' learning styles on their preconceptions of the ease of learning from media, the amount of mental effort invested in learning from a video-based lesson, and their learning achievement. In addition, the reciprocal relationship between learners' experiences of success or failure in learning from a video-based lesson and their subsequent perceptions of the ease or difficulty of learning from the medium in the future should be investigated. Salomon (1981) reminds us that mental effort has motivational as well as cognitive components; therefore, future research should incorporate techniques intended to increase learners motivation into video-based instruction to determine the effects of these techniques on mental effort and achievement.

This paper has reviewed the current research literature and outlined factors that must be considered in future investigations of learners' preconceptions of video-based instruction, the mental effort invested in learning from such a lesson, and techniques to increase the effort invested in processing a video-based lesson. The results of this research should provide instructional designers, video producers, and teachers with practical means of increasing the effort that learners spend in processing video-based materials so that the ultimate goal of the designer, the producer, the teacher, and the learner can be met as efficiently and effectively as possible- that of the achievement of the desired learning outcomes.

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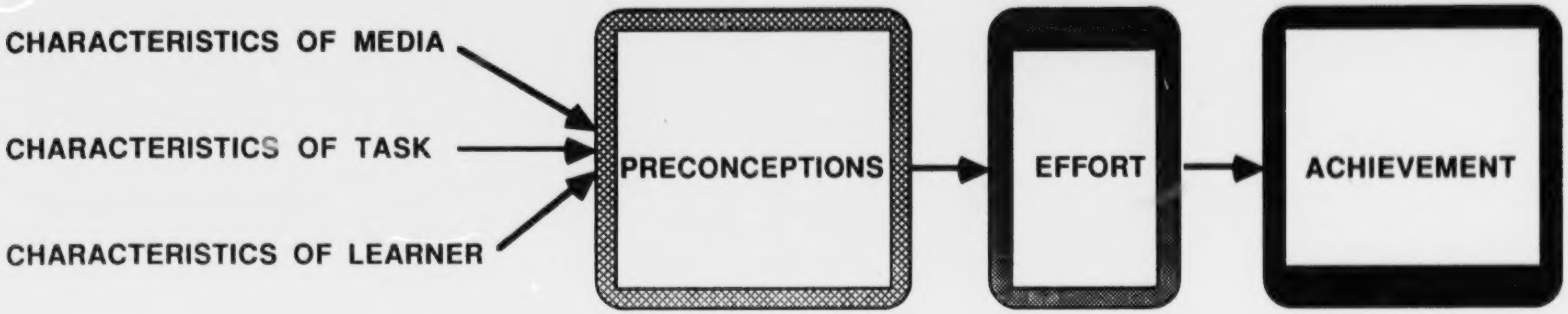
CHARACTERISTICS OF MEDIA
CHARACTERISTICS OF TASK
CHARACTERISTICS OF LEARNER
PRECONCEPTIONS
EFFORT
ACHIEVEMENT

Figure 1

Title:

Preconceptions of Mediated Instruction For Various Domains of Learning Outcomes

Author:

Katherine S. Cennamo

Preconceptions of Mediated Instruction for Various Domains of Learning Outcomes

Individuals involved in teaching and training are confronted with a vast array of potentially beneficial instructional media. Text, television, computers, and other media all promise to improve learner attention and achievement. Several researchers (Krendl & Watkins, 1983; Merikoff, 1980; Salomon, 1983; Salomon & Leigh, 1984) have suggested that learners' preconceptions of media are an influential factor in achievement. For example, Salomon (1984) found that learners perceive television as easier than books, yet they learn more from a text-based lesson. Salomon concluded that learners' perceptions of television as an easy medium resulted in a passive response toward learning from that medium and, thus, reduced achievement. The results of these studies have been assumed to apply to learning from computers (Dalton, 1986; Salomon & Gardner, 1986) and interactive video (Hannafin, Garhart, Rieber & Phillips, 1985; Schaffer & Hannafin, 1986); however, there is very little data that has explicitly examined learners' preconceptions of these newer media.

Although several versions of schema theory have been proposed to explain the relationship between learners' preconceptions of the ease of learning from a medium and their achievement, the construct of scripts proposed by Shank and Ableson (1977) may provide a reasonable explanation for this phenomena. As described by Schank and Ableson (1977) scripts guide information processing by prescribing appropriate sequences of actions in well known situations. The extent to which learners perceive a medium as easy or difficult may provide insight as to the nature of the scripts that are operating when attending to a lesson presented through that medium.

Although earlier research (Salomon,1983; Salomon, 1984; Salomon & Leigh, 1984; Krendl, 1986) found that learners' preconceptions of the ease or difficulty of learning a lesson depended on the medium of presentation, Beentjes (1989) found that students' ratings of the ease or difficulty of learning from a particular medium was strongly dependant on the topic of the lesson.

It is possible learners are aware that certain media are more effective than other media in facilitating the acquisition of certain learning outcomes. Gagne (1985) classified objectives as psychomotor skills, intellectual skills, verbal information, or affective learning, depending on the requirements of the task. Like many others, he proposed that the most effective medium for presentation is partially dependant on the desired learning outcome.

If students are somehow aware that one medium is more effective than others for the teaching of a given outcome, the differences in perceived difficulty observed by Beentjes (1989) may have been the result of the differences in learning domains represented by the topics on his questionnaire.

In Cennamo's (in press) investigation of learners' preconceptions of the ease of learning tasks representing various learning domains through the media of books, computers, television, and interactive video, she found that the symbol systems and processing capabilities represented by the media may have influenced learners' perceptions of the ease of the task. The students' ratings of the ease of learning various tasks using interactive video, computers, television, and books seemed to reflect some awareness of the external conditions needed for optimal learning in each domain. Learners rated interactive video and television as the easiest from which to learn psychomotor skills. The learners' ratings of the ease of learning psychomotor skills from television and interactive video may have reflected an awareness that demonstrations are a valuable asset when learning psychomotor skills. Likewise, modelling is suggested as a condition which will facilitate the adoption of an attitude change, and television and interactive video, the two media where behavior can be most easily modeled, were rated as the easiest from which to learn attitude skills. On the other hand, practice and feedback are valuable conditions for the attainment of verbal information and intellectual skills, and the students rated computers and interactive video, the media which would most easily provide practice and feedback, as the easiest from which to learn these skills.

But what influences learners' preconceptions of media? Why do learners view one media as easier or more difficult than another for a particular task? This exploratory study attempted to address these questions.

Purpose of study. This study was conducted as an initial step in determining what factors which contribute to learners' preconceptions of the ease or difficulty of learning a specific task using a specific medium. It examined whether the preconceptions of pre-service teachers varied by learning domain (verbal, intellectual, affective, psychomotor) or medium of presentation (interactive video, computers, television, books). Information was collected as to why the students perceived one medium as easier or more difficult than another for a particular learning task in order to gain insight as to the factors that contributed to students' preconceptions of media.

Methods

In this exploratory study, undergraduate students were asked to complete a self-report questionnaire on their preconceptions of the difficulty of four media (books, television, computers, and interactive video) and to participate in an individual interview.

Participants

Forty-two undergraduate students enrolled in an education class in a large midwestern university participated in the study. All of the respondents were female. Approximately 75% were elementary education majors and 25% were interested in child and family services. Twelve respondents were randomly selected to participate in a follow-up interview to solicit information on factors that contributed to their perceptions of ease or difficulty.

Materials

The preconceptions questionnaire included a cover sheet that operationally defined each medium in order to ensure that all participants interpreted the terms "books" "television", "computers", and "interactive video" in the same manner. Information was collected on the frequency of use of each medium. The students were asked to rate the difficulty of learning 12 tasks using each of the four media on a five-point Likert scale. One represented "very easy" and five represented "very difficult".

The questions were similar in format to those used by Beentjes (1989) and Salomon (1984). Whereas Beentjes and Salomon ask the learners to respond to questions such as:

- How difficult would it be for you to learn to solve a math problem from a book?

- How difficult would it be for you to learn to solve a math problem from television?

This questionnaire included questions such as:

- How ease would it be to learn to open and maintain a checking account from

a book	*very easy*	1	2	3	4	5	*very difficult*
television	*very easy*	1	2	3	4	5	*very difficult*
a computer	*very easy*	1	2	3	4	5	*very difficult*
interactive video	*very easy*	1	2	3	4	5	*very difficult*

There were three questions for each learning domain (intellectual, verbal, psychomotor, and attitudes). The outcomes for each learning domain were selected from Dick and Carey (1990) and were assumed to fairly represent the type of task that would be classified within a particular learning domain. The questions included stems such as:

- How easy would it be to learn to change the tire on an automobile from... (psychomotor)

- How easy would it be to learn to choose to treat customers in a friendly, courteous manner from..... (attitude)

- How easy would it be to learn to label the parts of the human body using common terminology from ... (verbal information)

- How easy would it be to learn to open and maintain a checking account from... (intellectual skill)

Ratings were summed by medium and domain. Chronbach's alpha yielded an acceptable overall reliability coefficient of .87. Alpha coefficients for each media subscale are as follows: books, .83; television, .80; computers, .63; interactive video, .77. Alpha coefficients for each domain subscale were .72 for psychomotor, .83 for attitudes, .60 for intellectual skills, and .78 for verbal information.

Procedures:

During the seventh week of class, the participants completed a questionnaire assessing their preconceptions of the difficulty of each medium for each domain. The questionnaire was presented as a normal part of the class, and all students who were present completed the questionnaire. At this time, the researcher invited the participants to sign-up for an interview. Although the participants were offered a small amount of extra credit for participation in the interview, the structure of the course allowed the students to earn course credit in a variety of ways and they were offered the opportunity to participate in a variety of studies for credit throughout the semester.

Twelve students were randomly selected from the 26 students who volunteered to participate in the interview.

The students who were selected for individual interviews were asked to sign-up for an interview appointment. As they reported to the interview site, the interviewer explained the purpose of the interview and presented the participants with their previously completed questionnaires. For each task and medium, the interviewer read the question and the participants' responses aloud. The students were given the opportunity to change their responses, then asked to orally reflect on why they rated the medium as they did. These conversations were audiotaped and later transcribed.

Results

The data from the questionnaires were analyzed using a Repeated Measures Analysis of Variance to determine whether students preconceptions of the ease of learning a task varied by learning domain, by medium, or randomly depending on topic. The data from the interviews were entered into a database and sorted by question. The responses for each question were analyzed to determine trends in responses. The data analysis indicated several significant findings concerning learners' preconceptions of the ease of learning a given outcome using a given medium of presentation.

Analysis of Questionnaire Data

As expected, there was a significant difference among media, F (1,41) =18.6, p<.001, and among learning domains, F(1,41) = 9.41, p=.004. Interactive video was perceived to be the easiest to learn from (M = 23.14), and books were perceived to be hardest (M = 31.45). Computers (M = 26.93) were perceived to be easier than books and television, and television (M = 28.14) was perceived to be easier than books. Students perceived that it was easier to learn verbal information (M = 24.93) and attitudes (M = 26.50) than intellectual (M = 28.50) and psychomotor (M = 29.74) skills.

Table 1. Means for media and domains

	Books	Television	Computers	IVD	Domain Total
Psychomotor	9.64	6.05	8.24	5.81	29.74
Attitude	7.79	5.45	7.52	5.74	26.50
Intellectual	7.19	8.69	6.36	6.26	28.50
Verbal	6.83	7.95	4.81	5.33	24.93
Media Total	31.45	28.14	26.93	23.14	

Note: n = 42

As expected, there was also a significant interaction among learning domain and medium, F(1, 41) = 35.54, p< .001. Learners perceived that it was easier to learn psychomotor skills from television (M = 6.05) and interactive video (M = 5.81) than from computers (M = 8.24) and books (M = 9.64). For the learning of attitudes, learners also perceived it to be easier to learn from television (M = 5.45) and interactive video (M = 5.74) than from computers (M = 7.52) and books (M = 7.79). Learners perceived it to be easier to learn intellectual skills from interactive video (M = 6.26) and computers (M = 6.36) than from books (M = 7.19) and television (M = 8.69). The same trend continued for learning verbal information: Computers (M = 4.81) and interactive video (M = 5.33) were rated easier than books (M = 6.83) and television (M = 7.95).

In examining the means by medium, the results indicate that it is perceived to be easiest to learn verbal information from books (M = 6.83), followed by intellectual skills (M = 7.19), attitudes (M = 7.79), and psychomotor skills (M = 9.64). For television, it is perceived to be easiest to learn attitudes (M = 5.45), followed by psychomotor skills (M = 6.05), verbal information (M = 7.95), and intellectual skills (M = 8.69). It is perceived to be easiest to learn verbal information from computers (M = 4.81), followed by intellectual skills (M = 6.36), attitudes (M =7.53), and psychomotor skills (M = 8.24). For interactive video, the learners perceive it to be easier to learn verbal information (M = 5.33), followed by attitudes (M = 5.74), psychomotor skills (M = 5.81), then intellectual skills (M = 6.26).

Analysis of Interview Data

The frequently listed responses were sorted into several categories. The majority of the responses referred to the symbol systems offered by the various media. Participants mentioned the presence or absence of pictures, graphics, live demonstrations, moving images, and related symbols. The second most frequently mentioned category of responses referred to the processing capabilities offered by the media. Responses in this category referred to the ability of the media to present questions, ease of reviewing information, option of controlling the pace of the presentation, possibility for practice with feedback, and similar responses. The third most frequently mentioned category of responses involved the learners' preferences for certain media. Responses in this category included the learners' familiarity with learning a particular task with a particular medium, the extent to which they found presentations using a certain media interesting, and other personal preferences. Other responses mentioned the physical limitations of the technology. Participants mentioned the portable nature of books, the fact that videotapes could be shown at certain locations, and the accessibility of computers and books. A few participants referred to characteristics of the task when asked why they rated a particular medium they way they did for a particular task. These responses referred to the perceived ease or difficulty of the task in question.

Based on the results of the statistical analysis, the interview data was interpreted in terms of the media by domain interaction. Only those responses that were mentioned by five or more participants will be included in the following discussion. Some of the participants responded that computers or interactive video were "like books" or "like television", but provided no other reasons for their responses. Due to the lack of relevant information in these responses, they will not be included in the analysis. (See Table 2)

Table 2: Table of responses mentioned by five or more participants

Attitude Skills	
Books	
self-paced, can skim, can review	9
Boring	8
easy task	6
Television	
see how to do, demo	11
see it modeled	8
interesting, entertaining	5
Computers	
same as books	12
graphics and pictures	5
read and follow steps	5
interesting and gains attention	5
no live demos	5
Interactive Video	
same as TV	12
demonstrations, person models	11
questions, participate, interactive	7
visuals	5
involvement, questions, exercises	6
TV and computer	5
demonstrate steps	5
like TV	5

Verbal information	
Books	
labels, diagrams, pictures	12
facilitate memorization	8
familiar	6
Television	
show instead of tell, point out things	11
pace	10
visualize/ see it	5
need interaction & hands on	5
Computers	
show pictures with labels	11
interaction & quizzes	10
like books	9
hands-on	9
Interactive Video	
Quiz/ interaction	6

Intellectual skills	
Books	
task easy (or hard)	12
familiar	12
telling what to do, directions	5
Television	
lack of interaction, just watch	10
set pace & can't review	8
someone just tells you	6
Computers	
Like books	12
practice problems and questions	7
step-by-step	7
hands-on involvement	5
Interactive Video	
watch someone	7

Psychomotor Skills	
Books	
Lack of demo, can't see it done	11
step-by step instructions	7
Television	
see it done	29
can model	7
Computers	
not real pictures	8
graphics & animation	6
like books	8
Interactive Video	
moving images and sound	8
control of pace & review	7
see someone doing it/ demo	7
like TV	7
questions and quizzes	5

Psychomotor skills. When learning psychomotor skills, the participants felt it was important to be able to see the skill demonstrated. This characteristic was the most frequently cited reason for rating television and interactive video as easy, and most frequently cited reason for rating books as a difficult medium from which to learn psychomotor skills. In examining the responses to the question on psychomotor skills mentioned by five or more participants, the vast majority of the responses referred to the symbol systems offered by the media in question. Interactive video was the only medium for which there were frequent responses mentioning any other category. The processing options available through the medium of interactive video were perceived as a positive addition to the ability to view actual demonstrations. Several respondents mentioned that interactive video would allow them to answer questions, review the content, and control the pace of the presentation.

Verbal information. When learning verbal information, the participants felt that the processing capabilities offered by the media were at least as important as the symbol systems. The ability of computers and interactive video to provide hands-on interaction in the way of practice questions and feedback was mentioned quite frequently as a reason for the perceived ease of these two media. Conversely, the lack of learner control over the pace of a television program was mentioned most frequently as a reason why television was rated as a difficult medium from which to learn verbal information. The symbol systems offered by the media were also important. Pictures with labels were viewed as positive features of computers and books, and the fact that someone was simply "telling" you information was viewed as a negative aspect of television. Respondents also mentioned that they were familiar with learning verbal information from books and that they felt the format of books facilitated memorization of verbal information.

Attitude skills. The ability of a medium to present a live model demonstrating the desired behavior was viewed as the most important characteristic for increasing the ease of learning an attitude. This ability was seen as a positive characteristic of television and interactive video and the lack of such ability was seen as a negative characteristic of computers. The ability of a medium to provide visuals, graphics and pictures was also perceived to facilitate the ease of learning attitudes. Learner preferences also were viewed as very important in the ease of learning attitudes. The participants frequently mentioned that learning an attitude from television and computers would be interesting and entertaining, yet learning attitude skills from books would be boring. However, the self-paced nature of books was viewed as a positive characteristic in learning attitudes from books. Respondents liked the fact that they could skim over sections or review sections when they desired. Other individuals mentioned that the ease of learning an attitude from books was determined by the ease or difficulty of the task they were to learn.

Intellectual skills. Processing capabilities were viewed as important characteristics for facilitating the ease of learning an intellectual skill. The ability of computers and interactive video to provide practice questions and hands-on involvement in the learning of intellectual skills were frequently mentioned responses. Conversely, the lack of hands-on involvement was seen as a characteristic which made it more difficult to learn intellectual skills from television. The lack of learner control over the pace of television and the lack of the option of reviewing information were frequently given as reasons that participants rated television as a difficult medium from which to learn intellectual skills. Responses which mentioned the symbol systems offered by the respective media were the next most frequently mentioned category. The ability of computers and interactive video to demonstrate the skill in a step-by-step manner was perceived as important in facilitating the ease of learning intellectual skills. Although the ability to watch someone perform the skill was perceived as a positive characteristic when coupled with the processing capabilities of interactive video, the fact that someone "just tells you" how to do the skill was viewed as a negative characteristic of television. For the medium of books, the most frequent responses fell into the categories of characteristics of the task and learner preferences. The ease or difficulty of the task were frequently mentioned as reasons for participants' ratings of the ease or difficulty of learning from books. Just as frequently, participants mentioned their familarity with learning from books as a reason for their responses.

Discussion

The purpose of this study was to determine factors which contribute to learners' preconceptions of the ease or difficulty of learning a specific task using a specific medium. Participants completed a self-report questionnaire assessing their preconceptions of the ease of achieving various learning outcomes (psychomotor, affective, verbal, intellectual) using the media of interactive video, computers, books, and television, and participated in individual interviews in which they were asked to verbally reflect on their responses to the questionnaire.

The results of this study indicated that the participants viewed interactive video, computers, television, and books as very different in their ease of learning. Contrary to previous research (Krendl, 1986; Salomon, 1984; Salomon & Leigh, 1984), the participants did not consistently rate books as the most difficult medium. Instead, there was a strong interaction among the medium of presentation and the learning domain of the intended outcome. An analysis of the interview responses indicated that for different domains of learning outcomes, learners use different criteria for rating a medium as easy or difficult.

The participants indicated that for learning attitudes, the ability of a medium to present actual models demonstrating the desired behavior was an important factor in contributing to the ease of learning from a medium. Therefore, it is not surprising that television and interactive video are rated as the easiest media from which to learn attitude skills. Learners' personal preferences also seem to play a part in the perceived ease of learning an attitude from a given medium; the participants indicated that it would be boring to learn an attitude from books, while it would be interesting and entertaining to learn the same type of skill from television.

The ability of a medium to present an actual demonstration of the target skill was also an important factor in the participants' ratings of the perceived ease of learning a psychomotor skill, thus, they rated interactive video and television as the easiest media from which to learn this type of skill. In addition, the participants perceived that the added processing capabilities of interactive video which allow them to control the pace of the presentation, respond to questions, and review sections would further contribute to the ease of learning a psychomotor skill.

For the learning of verbal information and intellectual skills, the participants indicated that the processing capabilities of a medium would greatly contribute to the ease of learning from that medium. The ability of computers and interactive video to provide the learners with hands-on practice of the target skills was viewed as an important factor in their ratings of these media. In addition, the symbol systems offered by the media were mentioned as influential factors in their ratings. The presence of pictures with labels was mentioned frequently as an important factor in learning verbal information and the step-by-step demonstration of an intellectual skill was mentioned frequently as an influential factor which contributed to their perceptions of the ease of learning an intellectual skill.

It is interesting to note that learner preferences and task characteristics were frequently cited as reasons for the participants' ratings of the ease of learning from books. They frequently mentioned that they were familiar with learning a particular skill from books. In addition, the perceived ease or difficulty of the task itself was mentioned frequently as a reason for their ratings. It appears that the symbol systems and processing capabilities of books are less important factors in the participants' ratings of this medium than in their ratings of television, computers, and interactive video. Although the participants may be less familiar with computers and interactive video than books, they are assumed to be very familiar with television. However, their responses indicate that they may be more familiar with receiving instruction through books than through the other three media.

Although the commonly accepted viewpoint is that "...media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes chance in our nutrition" (Clark, 1983, p. 445), Kozma (1991) has challenged and expanded this commonly held view and proposed that the "capabilities of a particular medium, in conjunction with methods that take advantage of these capabilities, interact with and influence the ways learners represent and process information and may result in more or different learning when one medium is compared to another for certain learners and tasks " (p. 179). Kozma goes on to say "Whether or not a medium's capabilities make a difference in learning depends on how they correspond to the particular learning situation- the tasks and learners involved- and the way the medium's capabilities are used by the instructional design." (p. 182)

The results of this study suggest that learners' perceptions of the ease of learning a particular task using a particular medium are strongly influenced by the capabilities of the medium such as it's symbol systems and processing capabilities. In addition, their preconceptions are also influenced by characteristics of the learner and the characteristics of the task. Although this study has not attempted to determine which medium actually facilitated the ease of learning a particular task, it has attempted to determine what factors contribute to learners' preconceptions of the ease of learning a given task from a given instructional delivery system. Future research should continue to explore the relationship between learners' preconceptions of a medium and their actual achievement when learning from that medium.

It is important to recognize that this exploratory study has been conducted with a small number of female undergraduate education students. It is possible that, due to the past experience and academic major of this group, this population has an enhanced awareness of effective teaching/learning strategies that may not be present in the general adult population. Future research is needed to determine to what extent the findings of this exploratory study apply to the general adult population.

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Title:

The Effects of Visual Complexity in Motion Visuals on Children's Learning

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The Effects of Visual Complexity in Motion Visuals on Children's Learning

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Abstract

The purpose of this study was to investigate whether differences in the level of visual complexity in motion visuals have an effect on cognitive learning of students in different grade levels. The instructional content was a 14-minute video lesson concerning the motion of objects in the universe. A 3 (levels of visual complexity) × 2 (grade levels) factorial, pretest-posttest design was used. Three 4th- and three 8th-grade classrooms were randomly assigned to one of the three video treatment groups. All subjects received the pretest, treatment, and posttest. Pretest and posttest consisted of 28 multiple-choice questions and were designed to test subject's comprehension of the instructional content. The results indicated that providing different levels of visual complexity in motion visuals had no significant impact on children's comprehension of the intended learning. Also, no interaction between amount of visual complexity in motion visuals and grade level was found.

Introduction

With the continually increasing impact of visual messages in our society, visual instruction has become one of the major methods of communicating information in school settings. A variety of visual materials, such as drawings, photographs, film, television, and computer software, is commonly used to complement regular classroom instruction at all levels of education (Dwyer, 1978, 1982-83). Prior research has demonstrated that pictures are a versatile instructional tool. It can help children learn many different tasks, such as learning from oral prose (Levin & Lesgold, 1978), learning of nonfictional passages taken from newspaper (Levin & Berry, 1980), learning of written text (Levie & Lentz, 1982), and word recognition (Willows, 1978). However, studies of visual instruction also show that the inclusion of a picture in instruction does not automatically improve student achievement (Dwyer, 1978; Levie & Lentz, 1982; Peeck, 1987). Different visuals containing different amount of visual complexity may affect learning differently.

Over the years, two opposite approaches to designing instructional visual materials have arisen from the concept of visual complexity. They are realism theory (Carpenter, 1953; Dale, 1946; Morris, 1946) and relevant cue hypotheses (Miller, 1957; Travers, 1964; Travers & Alvarado, 1970). The basic assumption of realism theory is that learning will be more complete as the amount of visual detail in the instructional materials increases. However, relevant cue hypotheses contend that complex visuals may be interesting to view, but due to the limited capacity of human information processing, this type of visuals is more difficult for the brain to process.

Visual complexity can vary among a great number of different attributes. However, the amount of interior detail in figures and presence of background information are two attributes which have been implicated by researchers as important factors influencing learner's processing of visual information (Dwyer, 1978; Fleming, 1987; Franken, 1977; Nelson, Metzler, & Reed, 1974; Travers, 1969).

In a visual display, critical figures (objects or people) may show extreme variations in amount of interior detail. The range is from full color photographic representations to black-and-white outline drawings that portray only the few edges the artist considers to be of crucial significance in identifying the characters. In some studies, researchers have directly manipulated the amount of figure detail in pictures to determine whether extra interior detail facilitates different levels of learning in the cognitive domain. For example, since 1967 Dwyer (1978, 1982-83) and his associates have conducted more than 100 studies in this area. The results of these studies generally concluded that employing highly detailed, complex illustrations in visual lessons is unnecessary, and it may even impair the intended learning.

In addition to Dwyer's studies, a number of researchers have focused on the roles that varying levels of figure detail play in picture memory (Cody & Madigan, 1982; Evertson & Wicker, 1974; Jesky & Berry, 1991; Nelson, Metzler, & Reed, 1974; Ritchey, 1982; Travers, 1969). Unfortunately, contradictory results are found among these studies. For example, Evertson and Wicker reported that the retention of visual stimuli was positively related to the amount of detail in stimuli, whereas Ritchey found that outlines were recalled significantly better than detailed drawings. Therefore, further research is still needed to determine the influence of the addition of figure detail on cognitive learning.

The influence of background information on cognitive learning is another question examined in the research on visual complexity. Many researchers have indicated that perception of a visual figure is determined not only by its characteristics but also by its surrounding context (e.g., Antes & Metzger, 1980; Fleming, 1987). In general, background information refers to the excess surrounding information in which the critical figure is embedded (Borg & Schuller, 1979; Fleming & Levie, 1978; Sparks, 1973). According to this definition, pictures may vary in the extent to which the critical figure in the picture is presented in context or in isolation. A number of empirical investigations have focused on the presence or absence of background information in a visual. One of the earliest reported studies was conducted by Spaulding (1956). He found that visual information unnecessary to critical figures should be eliminated because it may motivate an interpretation that is not compatible with the purpose of the illustration. However, in contrast to Spaulding's findings, Antes and Metzger (1980) reported that the context (background) of objects helped learners construct a general characterization of the pictures which provided learner expectancies to perform their discrimination task. Therefore, the research results concerning the influence of background information on cognitive learning thus far are inconclusive and usually contradict one another.

While the research indicates that visuals containing varying levels of complexity have different effects upon learning, many researchers find that these effects interact with learner age. A number of empirical studies have been conducted which attempt to establish the relationship between the complexity of a picture and a child's ability to process it (e.g., Collins, 1970; Evertson & Wicker, 1974; Hagen, 1972; Hale & Taweel, 1974; Moore & Sasse, 1971; Pezdek & Chen, 1982; Pezdek, 1987). Although the research results appear inconsistent to some extent, in general, researchers agree that there are age differences in how the children allocate their attention to a visual task. Young children tend to center perceptually on selected aspects of a picture, while older students are better able to view the picture in a more global manner. Unfortunately, however, at present there is still very little guidance for educators in selecting visuals that are appropriate for use with specific groups of learners.

In reviewing the studies concerning the effect of visual complexity on learning, it is evident that they frequently have used static visual stimuli as the material to be learned. Only a few studies have attempted to investigate the relative effectiveness of motion visuals that employ different levels of visual complexity to complement verbal instruction (Acker & Klein, 1986; Chou, 1991; Dwyer, 1970; Hozaki, 1988). In view of the increasing use of motion visuals in school settings today, there is no doubt that more research work needs to be conducted regarding this area.

The purpose of this study was to examine whether, or to what extent, differences in the level of visual complexity in motion visuals have an effect on cognitive learning of students in different grade levels. Specifically, the amount of figure detail and background information were two attributes of visual complexity examined in this study.

Methods

Subjects

Subjects for the study consisted of three 4th-grade classes (N=78) and three 8th-grade classes (N=72) from two public schools in north central Florida. They were randomly chosen by the two school principals and the school curriculum coordinators. All of the classes selected were average classes and were similar to one another.

Instructional Content

The instructional content selected for this study was a 14-minute video lesson concerning the motion of objects in the universe. The lesson was divided into three units: (a) motion and force, (b) gravity, and (c) the law of inertia. In each unit, a related question was first posed, and then the basic concept as well as some real-life examples of this concept were explained and demonstrated. During the development of the lesson content, it was reviewed periodically by practicing teachers of 4th and 8th grades so that both grade students could easily understand the instructional material.

Instructional Treatments

The treatments for this study were produced in two phases. In phase one, three versions of black-and-white computer animation were created using the ADDmotion animation program that runs on a Macintosh environment. After the three versions of computer animation had been produced, the next phase was to convert them to be three VHS videotapes by recording the image from a computer monitor with a professional studio camera.

The videotapes represented three different levels of visual complexity in motion visuals for this study: outline drawings (OD), outline drawings with added figure detail (ODF), and outline drawings with added figure detail and background information (ODFB). Although the three versions of the video programs had different levels of visual complexity, they all employed the identical verbal narration to complement the visual information.

In the OD version, the computer animation contained only the outline shapes of critical objects necessary to convey the intentional meaning of the picture. Peripheral information, such as figure detail and background, was not included (see Figure 1).

In the ODF version of computer animation, interior detail in figures was added to each frame of the OD version. If the critical information of a frame was a girl pushing a toy car, for example, the

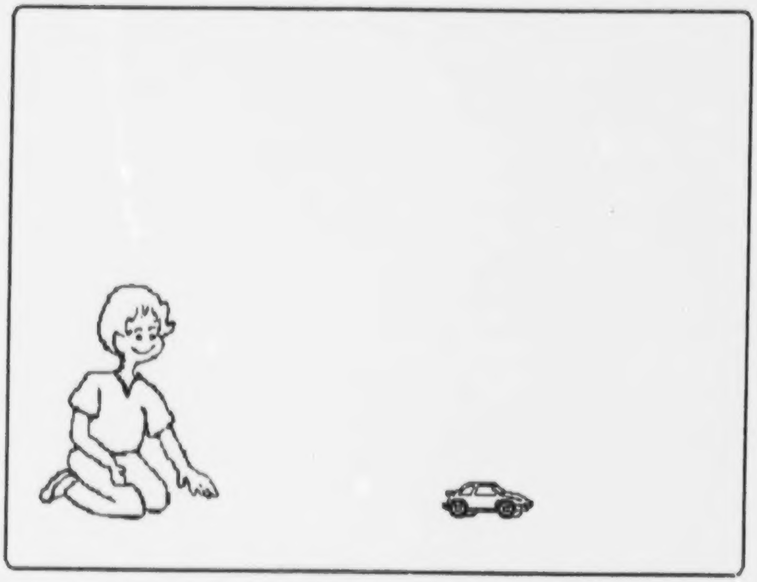

Figure 1: A Sample Frame in Outline Drawings (OD)

added interior detail would include the designs on the girl's clothing as well as shade and design patterns in the toy car (see Figure 2).

The ODFB version was presented with the same visual information as the ODF version except that appropriate background information was provided in each frame. For example, the visual of a girl pulling a toy car in the ODF version would be embedded in a living room in the ODFB version (see Figure 3).

In order to eliminate variables which may confound the research results, all pictures were developed as black-and-white representations. In this way, the possibility of color effect could be avoided.

Instrumentation

The pretest measure (K-R 20 = .87) dealt with the specific content covered in the selected video lesson. It consisted of 28 multiple-choice questions which tested students' comprehension of content which would be presented in the video lesson. The posttest was identical in style to the pretest and consisted of the same 28 items but arranged in a different order. The posttest was administered to the subjects two weeks after the pretest was given.

These measures required that the student had a thorough understanding of the concept of motion, gravity, and the law of inertia. They were designed to determine whether the students comprehended what was communicated and could use the information being received to explain some other phenomena.

Procedure

Three 4th- and three 8th-grade classrooms were randomly assigned to one of the three video treatment groups–OD, ODF, and ODFB group. After being assigned the treatment groups, the

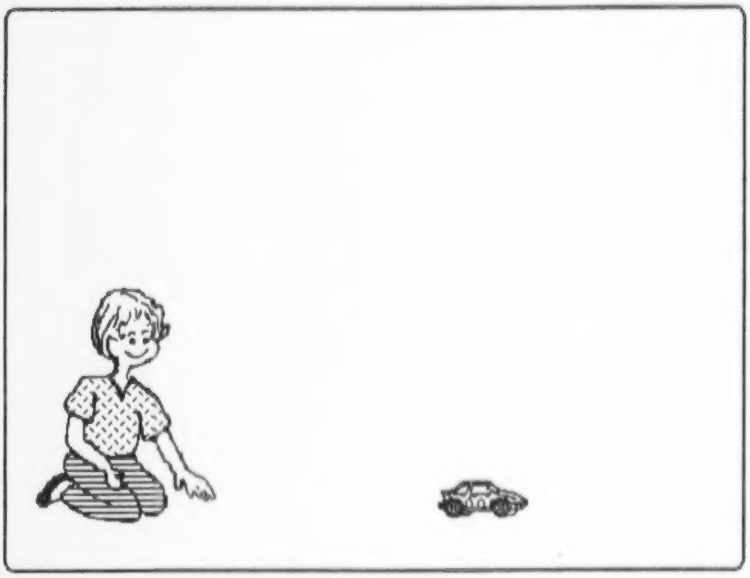

Figure 2: A Sample Frame in Outline Drawings with Added Figure Detail (ODF)

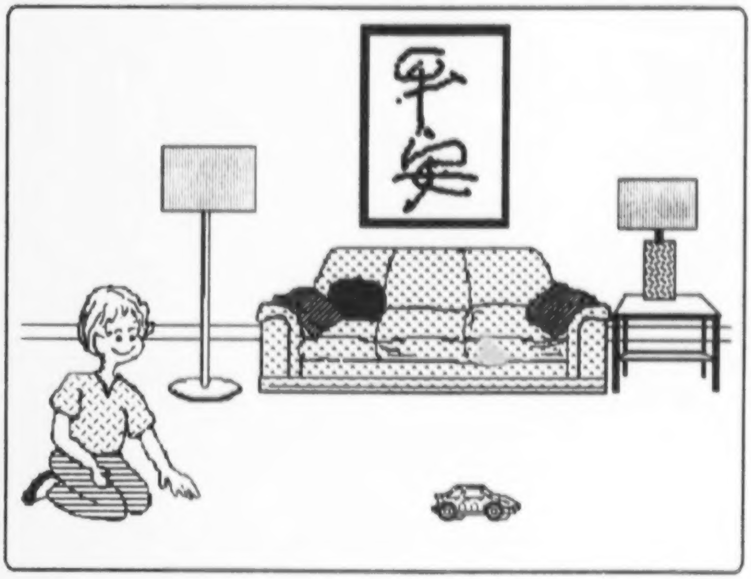

Figure 3: A Sample Frame in Outline Drawings with Added Figure Detail and Background Information (ODFB)

subjects received the pretest to determine their prior knowledge level in the instructional content. However, since the possibility existed that the pretest might activate students' attention toward some specific areas of the video program when they would watch it later, the pretest was administered two weeks before the experimental treatments were delivered.

During the two-week period between the pretest and the experimental treatment, the teachers were asked not to teach the content areas concerning motion and force, gravity, and the law of inertia. They were also requested not to answer students questions relating to these areas.

After two weeks, subjects received their respective experimental treatments. The video treatment was played on a 20-inch monitor. Upon the completion of playing the experimental treatment, subjects received the posttest.

Results

The design of the experiment was a 3 (levels of visual complexity) × 2 (grade levels) factorial, pretest-posttest design. In order to determine whether there were existing group differences in achievement levels of subjects in different treatments, a pretest-posttest correlation and an ANOVA procedure were utilized. Pearson correlation coefficients indicated that pretest was highly correlated to posttest ($r=.75$) and an analysis of variance also showed a significant difference ($F=5.94$, $p< .005$) for pretest scores among the three treatment groups. Therefore, an analysis of covariance procedure (ANCOVA) was used for analyzing main effects and their interactions in this study, while the pretest scores served as a covariate to partial out their effect.

The pretest means, posttest means, standard deviations, and adjusted means for the three treatment groups by grade levels are presented in Table 1. Although the trend of the adjusted mean scores for the three treatment groups in 4th and 8th grade was different, the scores differed very little from group to group, a fact which was reflected in the small F ratios of the analysis of covariance procedure.

Table 1
Pretest Mean, Posttest Mean, Adjusted Mean by Treatment Condition

	4th Grade			8th Grade			Overall
	Pre M (SD)	Post M (SD)	Adj M	Pre M (SD)	Post M (SD)	Adj M	Adj M
OD	12.79 (5.46)	18.04 (7.38)	17.90	21.08 (4.68)	23.04 (5.45)	22.14	19.83
ODF	14.67 (4.10)	18.67 (5.58)	16.81	20.00 (4.38)	22.67 (4.00)	22.47	19.65
ODFB	10.48 (4.77)	13.59 (6.01)	15.57	17.55 (7.04)	19.90 (6.31)	21.30	18.30

Analysis of covariance procedures demonstrate that there were no significant differences for the main effect of treatment ($F=1.64$, $p> .05$), grade ($F=0.08$, $p> .05$), and interaction effect ($F=0.81$, $p> .05$). In addition, the F tests were also computed separately within each grade. All of the respective results are shown in Table 2, 3, and 4.

Table 2
Analysis of Covariance Summary

Source	DF	SS	MS	F
Treatment	2	61.59	30.79	1.64
Grade	1	1.42	1.42	0.08
Treatment × Grade	2	30.33	15.17	0.81

Table 3
Analysis of Covariance for Grade 4 (N=78)

Source	DF	SS	MS	F
Treatment	2	66.54	30.79	1.57

Table 4
Analysis of Covariance for Grade 8 (N=72)

Source	DF	SS	MS	F
Treatment	2	15.54	7.76	0.50

Discussion

The results of this study indicate that providing different levels of visual complexity in motion visuals has no significant impact on children's learning. The use of complex visuals contributes little to facilitate children's comprehension of the intended learning. These findings are in contrast to some earlier research which has previously reported that learning would be more complete as the amount of visual information, figure detail or background, in the instructional materials increased (Antes & Metzger, 1980; Evertson & Wicker, 1974; Snowman & Cunningham, 1976). Although the present study does not find that the most complex version of motion visuals (ODFB) impairs the intended learning, it supports Dwyer's (1978) observation that employing highly detailed, complex illustrations in visual lessons is unnecessary.

There is no interaction between amount of visual complexity in motion visuals and grade level. The differences among the adjusted mean scores for both 4th- and 8th-grader in three treatment groups are small. A number of researchers have theorized and tested the hypothesis that there is a developmental increase in ability to process visual information; specifically, young children have greater difficulty in selectively focusing their attention on the essential learning task than adolescent children (Collins, 1970; Hagen 1972; Hale & Taweel, 1974). However, this hypothesis is not supported in the present study. The adjusted mean scores among three treatments for 4th-graders do show variance (OD=17.90, ODF=16.81, ODFB=15.57), but are not significant. With regard to 8th-graders the variances of three adjusted mean scores are even smaller (OD=22.14, ODF=22.47, ODFB=22.30). Therefore, this study supports the results of Gorman (1973) in finding that the amount of visual complexity in visual instruction has no effect on cognitive learning of students in different grade levels.

Two possible explanations may have accounted for the lack of significant differences in this study. First, in contrast to the prior research which was generally limited to addressing the effects of visuals complexity on recognition and recall, the present study focuses on children's comprehension of visual information. Sigel (1978) has indicated that comprehension must be distinguished from recognition. To comprehend a picture is to extract meaning from the picture, whereas to recognize refers to the identification or labeling of a picture and does not require understanding. In the literature, only a few studies have attempted to include *comprehension* as one of the learning tasks to be examined (e.g. Dwyer, 1971; Hozaki, 1988). However, unlike other instructional tasks such as identification and psychomotor performance investigated in Dwyer's and Hozaki's studies respectively, various levels of visual complexity seldom make a significant impact on comprehension. Thus, this implies that humans may use different cognitive processes to recognize and comprehend a visual display. However, it is still not clear how these two processes are different. Further research has to be done before we can draw a general conclusion on this issue.

A second possible reason accounting for the lack of difference may have been that an insufficient amount of pictorial information was added to the two complex versions of treatments. In reviewing prior research in the field, most studies employed a much wider range of variations in visual complexity. For example, Chou (1991) used realistic video and animated simple computer-generated line graphics as the two levels of visual instruction. In Nelson, Metzler, and Reed's (1974) study the three visual stimulus conditions presented to subjects displayed significant variance: photographs, embellished line drawings, and unembellished line drawings. In contrast, the three treatments used in the present study are all computer-generated line drawings, though figure detail and background information have been added to the two complex versions. Gorman (1973) has suggested that the irrelevant detail did not interfere with the processing of the relevant information presented due to a tolerance level existed for some irrelevant information in a picture. Apparently, this research study is supportive of Gorman's observation. However, it is still not clear what the limits of the tolerance level is. Therefore, if the complexity among three visual treatments in this study could be increased to include a realistic video version, significant achievement differences among treatments may occur.

Several important implications for educational researchers and instructional designers are provided by this study. According to the subjects' progress in their achievement scores, it is clear that the use of visual instruction does improve student's learning. However, the three levels of visual complexity in motion visuals employed in this research study do not have any differential impact on children's comprehension of the intended learning. The more complex visuals are no more effective than the simple one. Therefore, the issue of whether to add extra pictorial information in instructional materials appears to be an economic rather than an instructional consideration. Instructional designers should first consider their budget limitations before making a final decision in selecting and producing appropriate visuals for learners.

The results of this study offers evidence that there is no significant relationship between the treatments and grade levels on learner's comprehension. No treatment condition serves to provide students in different grade levels with a more efficacious visual design strategy for affecting their achievement. Therefore, visual complexity may not be an important factor to be considered when teachers and instructional designers determine how to present motion visuals in order to facilitate the comprehension of learners at different ages. Either a common simple outline drawing or detailed drawing with background format can be used with equal effectiveness with a wide range of students from grade 4 through grade 8.

Another implication provided from this study is that since level of visual complexity is not a physical attribute restricted within a specific medium, the findings of this study may broadly apply to learning from film, television, computer, interactive video, or multimedia systems. That is, extra pictorial information cannot facilitate comprehension of the information presented in the motion visuals. Even though advanced media such as videodisc or digital video interactive (DVI) can present information that is more realistic, the incorporation of complex and detailed visuals into instructional materials is not necessary.

Recommendations

The results of this empirical study support the need for more extensive investigation concerning the design of visual instruction. The following recommendations are made for additional study in this area:

1. Different cognitive learning tasks could be employed to determine if the factor of visual complexity only influences specific cognitive learning tasks.
2. A wider range of variations in visual information among treatments could be used to determine if the level of complexity in motion visuals affects children's learning.
3. Subjects at a greater age difference could be used to determine whether the effects of visual complexity in motion visuals interact with learner age.
4. Studies could be designed to utilize different subject content areas to determine if the effects of visual complexity are restricted to the specific subject matters.
5. Color and other cueing strategies could be added to the motion visuals to investigate if children's comprehension is affected by them
6. Besides a multiple-choice test, other types of instruments could be included to examine if different results from the present study would be found.
7. Since a statistical method (ANCOVA) is used in the present study to control subject's existing differences, the same research could be replicated randomly assigning individual subjects to treatments to determine if the classroom effect influences the results of this study.

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Title:

Facilitating the Spontaneous Generation of Analogies in Problem Solving

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The shift from the behaviorist paradigm to the cognitive paradigm has led researchers to turn their attention to cognitive processes. Although the research has been impressive, it sometimes fails to translate clearly into instructional practice. Perhaps no place is this more apparent than in the study of analogies. Basic research has provided insight into the nature and mechanism of analogies (e.g., Gentner, 1983; Rumelhart & Norman, 1981; Sternberg, 1977a, 1977b), shown that analogical reasoning ability is a poor predictor of "the ability to infer from analogies" (Yacci, 1990), and demonstrated that learners can be taught to generate analogies (e.g., Lowenthal & Pons, 1987). Another line of research has focused on instructional applications, usually instruction-provided analogies. These applications have typically been in math and science with lower-level learning outcomes (e.g., Zeitoun, 1984). Instructional analogies have been found beneficial for learners from fifth grade (Simons, 1984) through college (Newby & Stepich, 1991). Occasionally researchers have investigated the role of analogies in facilitating higher-order outcomes. For example, Gick and Holyoak (1980, 1983) found that providing multiple analogs (i.e., cases or stories analogous to the target problem) can facilitate problem solving, although single analogs were generally effective only 40% of the time unless subjects were *prompted* to apply the analog.

While instruction-provided analogies require more instructional/learning time, performance gains generally offset the additional time required (Newby & Stepich, 1991; Simons, 1984). Nevertheless, the cognitive paradigm and growing interest in constructivism suggest a different perspective: Must analogies remain primarily time-consuming instruction-provided strategies, or can learners be empowered to spontaneously generate analogies to facilitate higher-order learning, and, if so, how?

Several lines of research guided our investigation into these questions. First, Gick and Holyoak (1980, 1983) showed that reading two relevant story analogs immediately before being asked to solve a problem facilitates the generation of a successful solution. However, since many of their subjects could also generate the appropriate solution from a single-story analog after they were prompted to use it in solving the problem, other cognitive processes might underlie the spontaneous generation of analogies to solve problems. Could subjects be taught to apply more effective cognitive strategies on single analogs rather than having to study multiple analogs? The former would potentially be a more efficient use of time and be available for wider transfer.

The importance of a broad knowledge base is supported by another line of research (e.g., Brown, Campione, & Day, 1981) which suggests that efforts to develop spontaneous analogical thinking may depend both on developing general knowledge ("world knowledge") and domain-independent strategies. Instructional strategies to develop spontaneous analogical reasoning are consistent with this view since they teach students to process information deeply by engaging in meaningful elaboration.

In the series of experiments by Gick and Holyoak (1980, 1983) subjects read one or two story analogs; subjects were usually told that they would be tested on the story. Various orienting tasks were required, most of which required little cognitive processing (e.g., single-sentence oral summaries of the whole story). Before they were tested on the story, subjects were asked to solve Duncker's (1945) cancer-radiation problem which was usually introduced as a tangential task. This case posed the problem of how to irradiate a tumor at sufficiently high doses, while avoiding damage to surrounding cells. The key solution to the problem was to simultaneously irradiate the tumor at low doses from different angles, resulting in a high cumulative dose at the tumor site. An analogous solution is suggested by The Attack-Dispersion Story (see Appendix), presented earlier to subjects, wherein armies avoided tripping land mines by dispersing troops along several different roads into a city.

The present study made use of Gick and Holyoak's content, and drew from Wittrock and Alesandrini's (1990) research method. All subjects in our study received The Attack-Dispersion Story. Depending on their assigned treatment, subjects were asked to process the story in different ways:

Summarize:	**Each paragraph of the story**	**The whole story**
Develop an analogy for:	**Each paragraph of the story**	**The whole story**

A fifth group was asked to simply record the time of completion for each paragraph, resulting in a 2 x 2 factorial design with an additional control group.

Our experiment differed from the Gick and Holyoak studies in significant ways, particularly relating to the generative model of learning (Wittrock, 1974). First, the Gick and Holyoak studies required little cognitive processing of the content; our experiment compared the effect of having to cognitively process each paragraph or the whole story (by summarizing or by generating an analogy) on the ability to solve the radiation problem. Second, the Gick and Holyoak studies did not direct the subjects to express the summaries totally in their own words, a requirement which is expected to facilitate more meaningful encoding (Wittrock & Alesandrini, 1990). Since conceptual analogies facilitate creative transfer of knowledge, while comprehensive analogies facilitate storing information (Stepich & Newby, 1988; Simons [1984] calls these respectively "unconnected" and "connected" analogies), we hypothesized that having to generate summaries or analogies for each *part* of the story, rather than just for the whole, would make the individual elements of the story analog more accessible and facilitate creative application (far transfer). This hypothesis also seems to be supported by Mayer's (1980) theory of assimilative encoding: "The assimilative encoding process results in a broader cognitive structure, which supports transfer to creative problem situations" (p. 109).

The present study examined whether an experimental treatment such as the one used by Wittrock and Alesandrini (1990), which encourages generativity and meaningful encoding, can facilitate spontaneous analogical thinking. Our study differs from that study in that it is measuring spontaneous generation of a relevant analog in solving a problem rather than the amount of factual material learned. Because of the limited access to students for testing, we did not examine relationships between verbal ability, analytic ability, and ability to solve the problem successfully.

Method

Hypotheses

We hypothesized that (a) generating summaries or analogies for an analog story, described in the procedure section, would facilitate subjects' abilities to generate the analogical dispersion solution to the radiation problem and (b) generating summaries or analogies for each part of the analog story would further facilitate subjects' abilities to generate the dispersion solution to the radiation problem.

Subjects

Seventy-one students enrolled in five courses in the graduate school of education at a public, urban university participated voluntarily in this study. We focused on graduate students because we believed that they would already know how to generate summaries and analogies. Three subjects were eliminated because they were already familiar with the criterion problem.

Materials

The Attack-Dispersion Story (Gick and Holyoak, 1980) served as the story analog (see Appendix). The story was divided into 4 paragraphs, rather than 2, to break the story into more salient parts and to allow for more summaries and analogies according depending on the treatment. All instructions were included in the test packets. Subjects in the summary groups were instructed to write a summary (of each paragraph or of the whole story). Subjects in the analogy group were instructed to write an analogy (of each paragraph or the whole story) and received the following example:

> Each analogy should consist of one or two sentences and should clearly relate the new ideas to familiar things. For example,
>
> ________ reminds me of ________; or
>
> ________ is like ________ .

Subjects were presented with the story prior to the Radiation Problem (Duncker, 1945; see Appendix), which served as the test problem.

Procedure

Subjects were told the purpose was to "study how people learn from written material. . . .You will be asked to study a very short story. Then we will give you a written test to find out what you learned from the passage. The information we obtain in this way may be of help in improving students' learning strategies." In three of the classes, the professors allowed class time for those who wished to participate; in the other two classes, the experiment was administered immediately after or before class (the students' choice). Students in each class were randomly assigned to five groups in a 2 x 2 design (4 treatments plus a control group): encoding task (generate summary, generate analogy) and level of processing (each paragraph, whole story).

Separate booklets were prepared for each treatment, and included the instructions, the analog story (The Attack-Dispersion Story), the radiation problem, and a questionnaire to collect demographic data (prior knowledge of the radiation problem, degrees, majors, how many graduate credits they have completed, age, and sex). Subjects in each treatment read The Attack-Dispersion Story and generated summaries or analogies; subjects in the control group read each paragraph of the story twice, recording the time after each reading. After they had finished the treatment, the radiation problem was presented as an extraneous problem so that subjects would not be prompted to connect the story to the problem. They were instructed to write all the solutions they could think of.

Evaluation. The summaries and analogies subjects generated during the treatment were evaluated using a procedure derived from Wittrock and Alesandrini (1990) to measure the extent to which subjects followed the directions and the extent to which the treatments induced the intended effects upon generation of the analog solution.

Subjects in the **summary treatments** received separate scores for following directions and for including salient content. Subjects in the paragraph-summary treatment received 2 points per paragraph if they wrote a correct summary, 1 point if they relied on words from the story, and 0 points if they wrote nothing (8 points maximum). They received 1 point per paragraph for salient content: (a) routes radiating from fortress; (b) full force required for the attack; (c) total force impossible from one route without producing unwanted harm; (d) dividing into small groups, using different routes, and converging simultaneously (4 points maximum). Subjects in the whole-summaries treatment were evaluated similarly, with 2 points maximum for following directions and 4 points maximum for content.

Subjects in the **analogy treatments** received a single score focusing on following the directions (responses were often so loosely worded that it was impossible to rate the correspondence between the story and the experience the subject was recalling). Subjects in the paragraph-analogy treatment received 3 points per paragraph for generating real analogies, 2 points for generating loose analogies, 1 point for writing something else, and 0 points for writing nothing (there were 12 points maximum). Whole-analogies were scored similarly (3 points maximum).

The responses to the test problem were evaluated for quantity (each solution received 1 point) and quality. The quality of the target solution was evaluated as follows: 2 points for radiation from different directions; 1 point for low-intensity; 1 point for simultaneity (or converging).

We each independently evaluated responses based on pre-determined criteria. Overall, there were 11 differences in scoring of the test; 5 were readily reconciled as errors or oversights. Pearson product-moment correlations between ratings were then calculated to estimate interrater reliability for the number of solutions ($r = .983$) and for the score on the test ($r = .987$).

Results

We focused our analysis on the average quality of the solutions to the radiation problem (maximum = 4). Because our design had only one level in the control group, we performed two analyses of variance: (a) a one-way 5-group ANOVA, and (b) a two-way ANOVA. Hypothesis 1—that generating summaries or analogies for an analog story would facilitate subjects' abilities to generate the analogical dispersion solution to the radiation problem—was not supported. Hypothesis 2—that generating summaries or analogies for each part of the analog story would further facilitate subjects' abilities to generate the dispersion solution to the radiation problem—was partially supported. Table 1 shows the mean scores of the solutions.

Table 1. Mean Scores of Solutions *

	Analogy	Summary	Reading (control)	
Paragraph	2.11 (n = 14)	1.75 (n = 12)		1.94 (n = 26)
Whole	.89 (n = 14)	.68 (n = 14)		.79 (n = 28)
	1.50 (n = 28)	1.17 (n = 26)		
	1.343 (n = 54)		.79 (n= 14)	1.22 (n = 68)

* maximum score = 4

The one-way ANOVA indicated that the differences between the means of the five groups (Table 1) approached significance ($p = .069$). Because the difference approached significance, we decided to compare the groups as we had initially planned. A Fisher PSLD *post hoc* test revealed statistically significant differences ($p < .05$) between the paragraph-analogy group and (a) the whole-analogy group, (b) the whole-summary group, and (c) the reading group. A two-factor ANOVA, with the control group data omitted, further clarified the effects of the treatments. It revealed a main effect for frequency of processing (Table 1, Paragraph and Whole); that is, subjects who responded to each paragraph with an analogy or a summary had a statistically higher mean score (p = .013) than subjects who responded at the end of the whole story. Although the analogizers scored higher than the summarizers (1.5 vs. 1.17), there was no main effect for the mode of processing. Thus, there was a clear value in responding to the story paragraph by paragraph, and, from the one-way ANOVA, possible value in analogizing rather than summarizing.

Other factors. In their answers to the test problem, 7 subjects, who were distributed in a nonsignificant pattern across treatments, referred to the analog story. Six of those subjects (85.7%) scored at least 3 on the test. An analysis of variance revealed a statistically significant difference (p = .0001) between the average test scores of those 7 subjects and the scores of the 61 subjects who did not refer to the analog story (3.5 vs. .967).

Quality of Processing

Surprisingly, the quality of summaries and analogies was not significantly related to solution of the radiation problem. Quality accounted for only 3 - 23% of the variance in all treatments, even though the quality of subjects' summaries and analogies varied greatly.

For example, the subject who wrote the following good summary scored 0 on the problem:

- A clever military leader succeeds in overthrowing a ruthless despot His troops evade destruction and entrapment by attacking the central fortress from diverse directions.

The range in the quality of analogies was even wider than for summaries. Probably the poorest analogy was the following, written by a subject who scored 0 on the problem:

- The general is great leader to make dicision quickly.

Occasionally, analogies were very general comparisons, sometimes so broad as to seem useless. For example:

- Dictator is like many kings of medieval times. Dictator reminds me of Russian czars. The great general is like Stalin.
- Capturing the fortress is like solving a problem.
- This reminds me of two things—the Alamo and the Ho Chi Min trail.

Yet even subjects who drew direct analogies, sometimes paragraph by paragraph, to Desert Storm did not necessarily get the correct solution to the problem (the Gulf War ended a few months before the study was conducted). For example:

(1) Kuwait fell to Saddam Hussein, he ruled from Iraq-Kuwait.
(2) UN forces gathered in surrounding countries—Scud missiles threatened & mines [were] planted.
(3) Waiting period of UN troops prior to attacking.
(4) UN troops attack from different directions with few casualties & Kuwait reclaimed.

Discussion

As predicted, cognitively processing the story in parts (paragraphs) rather than as a whole, or merely rereading it, facilitated solution of the test problem. This finding is consonant with the theory of deep processing (Craik & Lockhart, 1972), as well as with the generative model of learning (Wittrock, 1974) and the theory of assimilative encoding (Mayer, 1980).

Although the pattern of scores was in the expected direction (analogizing and summarizing greater than reading), the precise reason for the failure to find a main effect for mode of processing cannot be determined from the data. However, it seems likely that the subjects were not adequately skilled in analogizing and summarizing. We generally assumed that graduate students would possess adequate skills for both; yet their responses clearly indicated a wide range of skill levels, particularly in analogizing. This variability in skill levels hurt the internal validity and control of the study, but at the same time served to strengthen the study's external validity. Clearly university-level instruction must meet the needs of students with widely varying skills.

Another reason for the failure to find a main effect for the task (i.e., mode of processing) might be lack of adequate incentive. Hicken, Sullivan, and Klein (1992) found that incentive is a significant factor in subjects' performance in research studies. Future studies should provide improved incentives for solving the problem.

Although the paragraph-analogy treatment produced the best results, the potential effect might have been inhibited not only by an inadequate incentive but also by other factors. For example, some subjects in the paragraph-analogy treatment actually created partially or fully "connected" analogies (as in the whole-analogy treatment) rather than "unconnected" analogies (Simons, 1984) and may thus have inhibited the hypothesized creative transfer of knowledge. Seven subjects (50%) in this treatment drew at least one analogy to Desert Storm, particularly to Saddam Hussein and General Schwartzkopf; only 1 of the 4 who drew more than 1 comparison to Desert Storm got the correct solution. It is possible that subjects using Desert Storm as a "connected" analogy strongly coded the story simply as a "war story," thus making transfer to another problem less likely. As noted above, "unconnected" analogies facilitate creative transfer of knowledge, while "connected" analogies facilitate storing information (Stepich & Newby, 1988).

The ability to identify The Attack-Dispersion Story as an analog to the problem clearly facilitated solving the problem. But the data in the study provide no insight into why some subjects were able to make the connection. The 6 who referred to the story and scored at least 3 were dispersed across treatments; and they varied in age (34-52), sex (3 female, 3 male), undergraduate major (art, English, electrical engineering, education, economics). It is possible that others were aware of the connection but just did not mention in their solutions. Future studies should include debriefing of subjects to determine if they were aware of the connection.

In spite of the limitations of the study, the groups which processed parts rather than the whole scored higher on average than the other groups, with the paragraph-analogy group scoring higher than the paragraph-summary group. Theory does suggest an explanation for these differences. The first explanation derives directly from schema theory's explanation of semantic networks. These networks

> represent [the] knowledge structures which enable learners to combine ideas, infer, extrapolate or otherwise reason from them. Learning consists of building new structures by constructing new nodes and interrelating them with existing nodes and with each other. The more links that the learner can form between existing knowledge and new knowledge, the better the learner will comprehend the information and the easier learning will be. (Jonassen, Cole, & Bamford, 1992, p. 395)

It is assumed that analogizing and summarizing engage our semantic networks more than passive reading does. But this assumption does not explain why the whole-analogy and whole-summary treatments performed essentially the same as the re-read group.

We believe one explanation lies in the fact that paragraph-level processing tends to result not only in more discrete processing, but also in less "packaged" processing. That is, the "unconnected" analogies and summaries make the knowledge more accessible for far transfer than do "connected" analogies and summaries. This explanation is consonant with cognitive flexibility theory (e.g., Spiro et al. 1988) and it extends explanations of "unconnected" (conceptual) versus "connected" (comprehensive) analogies (e.g., Simons, 1984; Stepich & Newby, 1988) to summaries .

A final question is why the "unconnected" analogies tended to produce better performance than the "unconnected" summaries. Since both treatments were intended to produce meaningful encoding, this difference is not readily explainable. One explanation seems particularly plausible. Because analogizing is a less familiar study strategy it may have caused the learners to attend to details more carefully and thus made them more accessible during the test. However, this explanation as well as others must be explored in future research.

Implications for Instruction

The most important implications relate to focus and types of processing: Instructional strategies that engage the learner in generating summaries and analogies in the learner's own words of subcomponents rather than just main ideas tend to facilitate far transfer problem solving, at least in immediate situations. This finding is consonant with Wittrock and Alesandrini's (1990) findings and with the generative model of learning in general (Wittrock, 1974). It is also consonant with theories of conceptual versus comprehensive analogies (e.g., Stepich & Newby, 1988), and with cognitive flexibility theory (e.g., Spiro et al., 1988), which argues for the use of multiple analogies in instruction. Whether these findings apply to other domains, to delayed transfer, and to the study of longer text, and whether there are any aptitude-strategy interactions remain to be investigated.

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Appendix

The Story

1 A small country fell under the iron rule of a dictator. The dictator ruled the country from a strong fortress. The fortress was situated in the middle of the country, surrounded by farms and villages. Many roads radiated outward from the fortress like spokes on a wheel.

2 A great general arose who raised a large army at the border and vowed to capture the fortress and free the country and the dictator. The general knew that if his entire army could attack the fortress at once it could be captured. His troops were poised at the head of one of the roads leading to the fortress, ready to attack. However, a spy brought the general a disturbing report. The ruthless dictator had planted mines on each of the roads.

3 The mines were set so that small bodies of men could pass over them safely, since the dictator needed to be able to move troops and workers to and from the fortress. However, any large force would detonate the mines. Not only would this blow up the road and render it impassable, but the dictator would then destroy many villages in retaliation. A full-scale direct attack on the fortress therefore appeared impossible.

4 The general, however, was undaunted. He divided his army into small groups and dispatched each group to the head of a different road. When all was ready he gave the signal, and each group charged down a different road. All of the small groups passed safely over the mines, and the army then attacked the fortress in full strength. In this way the general was able to capture the fortress and overthrow the dictator.

Test Directions

Before you take a test to see what you learned from the story, we would like you to try to solve the following problem:

> Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. It is possible to operate on the patient, but unless the tumor is destroyed the patient will die.
>
> There is a kind of ray that can be used to destroy the tumor. If the rays reach the tumor all at once at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but they will not affect the tumor either.
>
> Without cutting the patient, what type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?
>
> In the space below, write down as many procedures as you can think of. If you need extra space, you may write on the back.

Title:

Learner-Generated Questions and Comments: Tools for Improving Instruction

Author:

Peggy Cole

Introduction

Traditional approaches to instructional design involve needs analysis, selection and sequencing of instructional strategies, and—if time and budget allow—an iterative process of formative evaluation and revision until the instructional package meets some pre-determined criterion for success. There are many problems to such approaches, not the least of which is the fact that formative evaluation often gets short shrift because of time and budget constraints. But a larger problem derives from the behaviorist roots of instructional design. Winn (1990) noted that approaches which are grounded in behavioral theory are "inadequate to prescribe instructional strategies that teach for understanding" (p. 53; see also, for example, Bednar, Cunningham, Duffy, & Perry, 1991). Winn (1990) argued that "design needs to be integrated into the implementation of instruction" (p. 53).

In this paper, I propose one strategy that integrates design into the implementation of instruction. Specifically, I argue that increased use of learner-generated questions and comments can benefit every stage of the instructional process—from design through implementation. My argument assumes that instructional strategies can do double duty. First, they can adapt instruction to students' needs "on the fly," and second, they can provide ongoing formative evaluation.

In the first part of the paper, I show how learner-generated questions and comments are an instance of a larger trend toward constructivism. Second, I describe one use of journals to elicit and respond to questions and comments. Third, I discuss the potential of learner-generated questions and comments in formative evaluation. Fourth, I discuss implications for instruction and learning. Finally, I offer recommendations for incorporating learner-generated questions and comments in the instructional design, development and implementation process.

Limitations of Adjunct Questions

It is a fairly common practice across disciplines to include adjunct questions in the students' text, courseware, or teachers' guides. Yet the research findings on the use of adjunct questions have often been contradictory, with outcomes varying on a wide variety of factors, including the placement of questions, level of questions, and type of learning outcomes (e.g., Lindner & Rickards, 1985). The effectiveness of adjunct questions is also challenged by the literature on individual differences such as motivation, prior knowledge, field dependence/independence. For example, according to Jonassen and Grabowski (in press), the structure which adjunct questions imposes should benefit field dependent students while interfering with the learning of field independent students, who are likely to benefit more from imposing their own structure on material.

Another limitation of adjunct questions is that they identify problems for learners rather than developing the learner's ability to identify problems. Many (e.g., Brown, Campione, & Day, 1981; Duffy & Jonassen, 1992; Frase & Schwartz, 1975; Gagné, 1980; Jonassen, 1985) have argued that the goal of education is to help students become independent learners. And being an independent learner involves not only solving but identifying the problems to be solved (Bransford & Stein, 1984).

In this regard, research has generally overlooked an instructional/learning strategy potentially more important than adjunct questions: learner-generated questions and comments. Depending on their metacognitive sophistication and cognitive orienting tasks (Rigney, 1978), students may generate such questions and comments as they read an assignment, complete an exercise (including answering adjunct questions), participate in class discussion, study for an examination, etc. Research has shown that students' comments, answers and even their questions can influence how they construct knowledge. For example, Chi and her colleagues' (Chi & Bassock, 1989; Chi, Bassock, Lewis, Reimann, & Glaser, 1989; Chi, de Leeuw, Chiu, & LaVancher, 1991; Chi & VanLehn, 1991) investigated students' self-explanations while studying worked-out physics examples. Chan, Burtis, Scardamalia, and Bereiter (1992) studied how students learn from text. And Feathers and White (1987) focused on students' development of metacognitive awareness in a college developmental reading class. I have been studying students' questions and comments in journals in a college literature course (Cole, 1991,1992).

As Stein and Bransford (1979) observed, "An emphasis on the types of questions students ask themselves may...have important implications for understanding individual differences in learning and retention" (p. 776). Although these differences would seem to have important implications for selection and sequencing of instruction, the traditional instructional design and development process pays little heed to students' questions and comments until the formative evaluation process. (Unfortunately, with the budgetary and time constraints typically imposed on instructional design and development, formative evaluation often gets short shrift, if it is included at all in the process [Martin Tessmer, personal communication, 1991].) In fact, the traditional instructional design and development process often seems to discount the potential of students' comments and questions.[1]

A Limitation of Experts

One of the problems of relying mainly on experts in selecting and sequencing instruction is that they find it difficult to decompose their knowledge, even with the help of designers and developers. Moreover, they are often out of touch with the needs of novices and may hold widely disparate views of the learners' needs.

For example, in a study of students' journals in a college introduction to literature class (Cole, 1992), I had planned to use faculty ratings of story difficulty to guide my selection and sequencing of stories. During the first week of the term, I administered the survey to the other six full-time members of the college-level English program. Four of the teachers had taught full-time at the college more than 20 years; the fifth had taught full time more than 15 years; the sixth had taught full time less than 2 years.

In spite of their expertise, the survey revealed no consensus. The faculty, none of whom used journals in their classes, did not agree unanimously on the rating of any story, although 83% (5 out of 6) did agree on the rating of one story (Faulkner's "The Bear" is Difficult). The faculty ratings for 29% of the 14 stories with which they were all familiar spanned the entire range (Easy, Moderate, Difficult). Including my ratings for those stories increased the disparity to 36%. The range of responses provides further justification of the usefulness of journals in communicating students' difficulties. If teachers with so much experience do not agree on the difficulty level, then at least some of them must have inaccurate schemata of their students' needs.

There is some evidence that journals help "experts" identify the needs of novices. My ratings agreed unanimously with those of a part-time composition/literature teacher who, for several years, has required her students to write journals. A follow-up discussion revealed that we had based our ratings on similar information we had obtained from students' journals more than from class discussions.

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[1] For example, Merrill (Gagné & Merrill, 1991) recently said, "Once in a while I get a good question, but most of the time I don't. Consequently, I don't think the students know what to ask anyway" (p. 31). Merrill is evaluating questions from the perspective of an expert, not from the perspective of a novice or even a journeyman. On the other hand, Scardamalia and Bereiter (1991, p. 37) found that even "children can produce and recognize educationally productive questions and can adapt them to their knowledge needs."

The Paradigm Shift

The emerging interest in learner-generated questions has followed closely on the heels of the paradigmatic shift in psychology from behaviorism to constructivism (Bruning, 1983; Resnick, 1983; also see Duffy & Jonassen, 1992) and the accompanying shift from mathemagenic instruction, which "seek[s] to control the information processing activities of the learner" to generative learning, which places the locus of control in the learner (Jonassen, 1985, p. 127). The generative/constructivist learning model is consonant with encouraging learners to become independent by learning how to learn (e.g., Jonassen, 1985).

"The generative model asserts that learners, when faced with stimuli. . .construct and assign meaning to that information based upon prior learning" (Jonassen, 1985, p. 11). In emphasizing the active role of the learner, the generative model has bearing on many recent focuses in instructional theory and research, from problem-solving, and schema theory, which explains comprehension in terms of the interaction between the reader and the text (e.g., Anderson, 1977; Rumelhart & Ortony, 1977), to the views of transactional analysis, which is applied so well to the study of literature by Rosenblatt (1978). More recent discussions of schemata (e.g., Clancey, 1992) emphasize that they are not stored mental structures but dynamic networks which are "constantly changing and always freshly created (albeit it out of previous activations)" (p. 153). Similarly, Spiro and his colleagues (e.g., Spiro, Coulson, Feltovich, & Anderson, 1988; Spiro & Jehng, 1990) describe a process of schema assembly (forming new schema from parts of many schemata) in ill-defined domains.

As active learners, "people tend to generate perceptions and meanings that are consistent with their prior learning" (Wittrock, 1974, p. 88) and with their "age, subculture, experience, education, interests, and belief systems" (Anderson, Reynolds, Schallert, & Goetz, 1977, p. 378; Bransford & Johnson, 1972). The process seems to require not only constant creation, as noted above, but also reception of information and availability and activation of relevant schemata (as described by Mayer, 1975, 1979, 1980). But, as Anderson et al. (1977) noted, students sometimes do "violence...to the 'data' contained in the text" (p. 371). Thus, it is important to design and develop instruction which can identify problems and support the learning process in a timely manner—that is, to help current students, not merely to improve instruction for future students.

Learner-generated Questions and Comments

One instructional intervention which seems particularly promising focuses on learner-generated questions and comments. The limited research on learner-generated questions has focused primarily on training learners to generate the type of questions that teachers will ask on tests and examinations (e.g., Andre & Anderson, 1978-79; Frase & Schwartz, 1975) or on studying. This approach generally assumes a common level of learner understanding and thus fails to address the individual learner's prior knowledge and misconceptions. Another approach is to study the relationship between question frequency and individual differences, such as prior knowledge (e.g., Miyake & Norman, 1979).

However, focusing narrowly on "questions" overlooks an intuitively more natural strategy of teaching students to articulate and reflect on the questions and comments they have as they try to master a domain.[2] The student's own questions and comments might paradoxically be viewed as enlarging what Vygotsky (1978) called the zone of proximal development.[3] When coupled with other instructional/learning strategies, such as journal writing or question sessions,[4] this strategy allows the learner to build more naturally on whatever prior knowledge he/she has, while providing an opportunity for the teacher to monitor the student's comprehension, identify misconceptions, and adjust instruction accordingly.[5] In anonymous evaluations of journal writing, several of my students have commented that the act of writing journal questions helped them focus their attention and sometimes helped them find the answer themselves (Cole, 1991, 1992). Such an approach is a departure from traditional instructional design and development. Fostering students' questions and comments assumes that the selection and sequence of instruction cannot be totally predetermined and that it requires adjustment "on the fly."

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[2] The cognitive apprenticeship model (Collins, Brown, & Newman, 1989) is exploring new territory, but does not directly address this issue.

A domain-specific strategy? Research must determine whether learner-generated questions and comments are more critical in some domains than in others. However, identifying bugs in procedural knowledge such as arithmetic seems easier (not necessarily easy) than in ill-defined domains such as understanding complex college-level short stories. In arithmetic, the teacher or the student can readily determine *if* the student has arrived at a wrong answer to a problem; and the teacher can identify the error(s) by having the student think aloud while working through a similar problem. Because the procedure for a given problem is clear cut, a computer program can even monitor students' actions, intervene, provide guidance, etc.

Teaching college-level short stories is much more complicated. First, a story may not have a single "correct" meaning; thus the teacher ideally should know not only the student's conclusion, but also his/her reasoning. Similarly, the student may have inferred a "correct" meaning from wrong or incomplete evidence. While solving arithmetic requires knowledge of a well-defined procedure, understanding a complex story is a dynamic process in which the meaning unfolds with each word, each phrase, each sentence, etc. The student may have a weak understanding of grammar (from pronoun use to participial phrases), or may miss a symbol, an allusion or irony. Moreover, the author often delays or even withholds information for artistic or affective purposes. The potential number of errors is infinite.

While students' journals cannot provide insight into every error, they often provide insight into critical problems, which the teacher can explore in class or in tutorial sessions.

Learning to Learn

Developing the ability to monitor one's comprehension, articulate questions, and explore answers requires time and practice. Writing journals as homework gives students adequate time to reflect and to try to answer their own questions. I found (Cole, 1992) that my students' journals contain significantly more comments than questions, apparently because once students identify a point of confusion most of them try to resolve it. As noted above, students often comment that the act of writing their questions often helps them discover the answers. Journal writing seems to help students expand their own zones of proximal development, making their tacit interpretations explicit and thus available for reflection and analysis. Thus journal writing seems to be an instructional approach that can help learners make the transition from being dependent on others to being able to learn on their own. It helps them move from what Vygotsky (1978) called the *other-directed to self-directed* stages of understanding.

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[3] Vygotsky (1978) defined the zone of proximal development as "the distance between the actual development level as determined by independent problem solving and the potential level of development as determined through problem solving under adult guidance, or in collaboration with more capable peers" (p. 86). Compare Bereiter's (1985) discussion of "the learning paradox."

[4] In their journals, I encourage students to ask any question or write any comment that they believe will help them understand the reading assignment better (with the exception of definitions of words, unless they are unsure of the appropriate definition).

In lieu of at-home journals, at the beginning of a discussion, I occasionally ask students to write the three questions they most want answered about the reading assignment; then I collect them and read them anonymously to the class. Occasionally I just have students ask their questions out loud and I write them on the board.

[5] If many students raise the same issues in their journals, then I respond to the class as a whole. If only a few students raise an issue, then I respond in each journal.

Moreover, journal writing gives *each* student the opportunity to ask questions, try to answer them, and express his/her understanding of a reading assignment. A few students do not have the opportunity to come up with all the questions and answers and make it impossible for other students to contribute to their own understanding. (Even if they have the opportunity in class discussions or in collaborative groups, some students don't take advantage of it, for various reasons, many of which relate to lack of confidence or fear of peer ridicule.) In describing their Jasper series, the Cognition and Technology Group at Vanderbilt (1992) emphasized the importance of each student having the opportunity to contribute to his/her learning. Journal writing, even more than class discussions and collaborative learning, guarantees such opportunities.

Although other instructional strategies theoretically can elicit students' questions and comments (e.g., encouraging students to ask questions in class, and asking students questions), most students, at least those in a community college, seem much more willing to share these privately than in public. (I base this conclusion on 25 years experience as a college composition and literature teacher as well as on student evaluations of journal writing.) Electronic networking provides an alternate vehicle for anonymous sharing of questions and comments (see Hubbard & Duffy, 1991). Unlike adjunct questions, learner-generated questions and comments run little risk of overwhelming low-ability learners or boring high-ability ones.

One Implementation

Setting

In the past eight years, I have incorporated journal writing as an instructional/learning strategy in approximately 30 classes of literature students at Arapahoe Community College, a large, public community college in a white-collar suburb of Denver, Colorado. Composition/literature instructors teach five classes with a maximum of 23 students. Students at the college vary greatly not only in reading ability[6] but also in age, academic majors, world knowledge, and motivation. More than half of the students work. The average age for many years has been at least 28 (spring 1992 it was 31.2), but the distribution is bimodal, with the majority of the day-time students being traditional college age and the majority of the night students being non-traditional age. While most of the students in my literature classes read at or above the 11th-grade level, occasionally a few students read at or below the 9th-grade level. At the other extreme, sometimes half the students read at or above the 16.9th-grade level (the highest level on the exam).

The more journals I read, the more I have become aware of the disparity between (a) the adjunct questions in texts and teachers' guides—resources I had relied on whenever I taught an unfamiliar work—and (b) the types of questions and comments in students' journals. The adjunct questions in most texts and instructor guides tend to address relatively high-level learning outcomes related to aesthetic principles—for example, synthesis and evaluation on Bloom's taxonomy (Bloom et al., 1956) and problem-solving on the Gagné-Briggs taxonomy (Gagné, Briggs, & Wager, 1988).[7] The questions and comments from a whole class generally span Bloom's and Gagné-Briggs' taxonomies, but students' problem-solving efforts tend to focus on what Kintsch (1989) calls the text-base and the situation model rather than on aesthetic principles.

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[6] The college requires all students who enroll in composition to take reading and English placement tests. In addition, I usually administer the Nelson-Denny Reading Test (Form E, 1981 edition) during the first week of my literature classes.

With such a range of questions and comments, it is imperative to be able to identify and respond to individual student needs; yet the nature of community college students presents particular challenges, in addition to the range in their reading abilities. Students often lack confidence to participate in class discussion (even if they read at the highest grade level). Thus if a teacher relies on adjunct questions or teachers' guides to select and sequence instruction, he/she is likely to talk over the heads of many students and bore others.

Journal Methodology

Instructions. Following are the instructions printed on the syllabus of my Introduction to Literature course (I refine the directions from time to time; I use essentially the same instructions in other literature classes):

> Write a journal for each story, at least a half-page long—but there is no maximum length. Write your journal in ink, using complete sentences—otherwise I will not be able to understand what you are asking or saying. Write any questions you have—except the definition of a word, unless you are unsure of the relevant definition—or any comments you would like to make about the story. The journal is not busy work, but is intended to help me know what you need help with in understanding the story. Write any questions you believe will help you understand the story now as well as later, for the examination—or any other questions you are just curious about. Journals are worth a maximum of 10 points each. If a journal meets the minimum requirements, you will receive 7.5 points—a grade of C; you will receive additional credit, depending on how much your questions and comments indicate that you are paying attention to all the elements as you try to understand the story. There are no *wrong* questions or comments (but there are questions and comments which ignore the details of a story). Journals are a tool for you to learn about what you don't know, not to show me that you already know everything. Even if you don't understand a story at all but ask questions about what you don't understand and indicate that you are paying attention to details, you can receive a 10.
>
> I will collect your journals at the beginning of the class on which they are due. If you miss that class, you may submit your journal at the beginning of the next class you attend.

Practice and resources. In addition to these instructions, I usually have students practice writing journals on a haiku poem in class and I read those anonymously to the class. (I begin with a haiku because it is easy to incorporate into one class session.) Then I use students' comments and questions as a basis for helping them understand the poem. Before students write their first out-of-class journal, I provide written descriptions of the processes three former students used in writing their journals, and a sample journal. The last two semesters students have also had access to HyperCard tutorials I developed on writing journal questions and writing journal comments (I am experimenting with requiring students to view the programs). After I return the first journals, we discuss any concerns the students have about writing journals. I encourage students to ask questions about the journal-writing process at any time.

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[7] Since most introduction to literature texts are organized by topic (e.g., characterization, theme, and symbolism), adjunct questions in the students' text generally focus on that topic in a single work. There are few if any questions to direct students' understanding of the other topics for that work. Moreover, most of the works have no questions at all.

Grading. I grade students' journals and return them at the next class, responding in writing and/or in class discussion. Some writers have advocated that journals not be graded; others (e.g., Holland, 1989; Roth, 1985) have said they found grading a necessary incentive. Still others have identified graded journal writing as an incentive for students to read assignments and reflect on them before coming to class (e.g., Bauso, 1988; Schwartz, 1989) and a means of increasing students' confidence in their understanding of the domain (e.g., Zuercher, 1989). Advice on grading and feedback abound (e.g., Bauso, 1988; Myers, 1988; Roth, 1985), yet no one has provided empirical support for particular recommendations.

Maintaining anonymity. Although some teachers (e.g., Fulwiler, 1989; Heath, 1988; Wilson, 1989) have students share their journals with the class, I always maintain the anonymity of students because I found (Cole, 1992) that on evaluations of journal writing some students objected to sharing even though they had not objected when I gave them the opportunity not to share their journals in groups. Moreover, students apparently censure what they write when they know other students will be the audience (Cole, 1992).

Adjunct Questions Versus Student Journals on One Story

A comparison of adjunct questions and student journals on one story illustrates the superiority of the latter in addressing students' needs. Below I compare typical adjunct questions on "The Cask of Amontillado," by Edgar Allan Poe, with excerpts from students' journals; the text my students use does not have adjunct questions on this story. I usually teach this story after students have written several journals. First I list some of the adjunct questions from one text (Table 1) and explain the weaknesses of the questions in addressing students' needs. Then I provide excerpts from students' journals to illustrate students' needs (Table 2).

Table 1. Adjunct Questions on "The Cask of Amontillado" from a Student Text

1. How does Montresor's opening paragraph explain the conflict in the story and foreshadow its resolution?
2. How does Montresor's apparent concern for Fortunato's health enhance the suspense of the inevitable climax.
3. How does the "supreme madness of the carnival season" provide an appropriate environment for Montresor to initiate his plot?
4. Why does Montresor wait a half-century to tell his story?

Critique of Questions in Table 1. The questions in Table 1 reflect the decomposition of the story by an expert. While these are ultimately worthy questions, they do not address the immediate needs of most students as they try construct a basic understanding of the story and of the classic concepts of fiction (e.g., *conflict*). Following is a brief analysis of the problems students would typically encounter in trying to answer the adjunct questions (numbers refer to the questions above).

1. Most students do not understand the text-base of the opening paragraph, particularly the following sentences:

> I must not only punish, but punish with impunity. A wrong is unredressed when retribution overtakes its redresser. It is equally unredressed when the avenger fails to make himself felt as such to him who has done the wrong.

Students typically need help in paraphrasing these sentences; in fact, meaningful discussion of the story *must* begin by helping the student understand the opening paragraphs—otherwise students cannot meaningfully anchor class discussion. Students also have difficulty identifying the *conflict* in a story. Before we ask students to "explain the conflict...and foreshadow its resolution," we should make sure they can identify the conflict (as well, of course, as understanding the concept of *conflict* in a story).

2. Many students miss the irony of Montresor's concern and most are unable to identify the point of climax when I raise that issue in class.
3. Most students have a single, inappropriate schema for "carnival season," one related, for example, to carnivals in shopping malls during the summer rather than to Mardi Gras. Moreover, many of my students do not even know what Lent is.

None of the adjunct questions in the texts I examined addressed two critical passages. Many students ask about the first one in their journals. Because the significance of the reference to the masons depends on complex world knowledge, its complete significance always stumps students even if they understand the double entendre (it also eludes most literary critics).

> ...His [Fortunato's] eyes flashed with a fierce light. He laughed and threw the bottle upward with a gesticulation I did not understand.
>
> I [Montresor] looked at him in surprise. He repeated the movement—a grotesque one.
>
> "You do not comprehend?" he said.
>
> "Not, I," I replied.
>
> "Then you are not of the brotherhood."
>
> "How?"
>
> "You are not of the masons."
>
> "Yes, yes," I said; "yes, yes."
>
> "You? Impossible! A mason?"
>
> "A mason," I replied.
>
> "A sign," he said.
>
> "It is this," I answered, producing a trowel from beneath the folds of my *roquelaire*.
>
> "You jest," he exclaimed, recoiling a few paces....

Nor does any of the texts address the following exchange which occurs during the climax, as Montresor is completing his live entombment of Fortunato:

> "Yes," I [Montresor] said, "let us be gone."
>
> "*For the love of God, Montresor!*" [emphasis in the original]
>
> "Yes," I said, "for the love of God!"

Only the most astute students note this passage in their journals, although class discussion indicates that they rarely understood its significance. Note in Table 2 that one student not only noted the passage but appeared to understand its significance (see Story Element "God, crisis"). However, since she had already studied the story in another course, it was impossible to know if this was her own perception. She was one of the best readers in her class and wrote the best journals on each assignment.

Journal Entries. The questions in Table 2 provide a strong contrast to the adjunct questions. I have provided excerpts to illustrate the diversity of issues and comprehension. A comprehensive listing is outside the scope of this paper. Students' journals on this story spring semester 1992 ranged from 146 to 1,173 words, with a median of 721 and a mean of 644.

Table 2. Excerpts from Students' Journals on "The Cask of Amontillado"

Story Element	**Journal Excerpt**
Carnival, setting	I can't recall exactly what the carnival season is all about. Isn't it something to do with the Easter season?
Character	It seems that all of the narrator's false concern could be picked up by Fortunato.
Character	The story never mentioned what the real motive for the killing of Fortunato [was]. Was Montresor justified? Was he just plain crazy?
Character	Why did Fortunato trust Montresor enough to go down there if he was such a bad guy and did so many rotten things to Montresor?
Character	Why did Montresor have doubts about the Amontillado?
Character	Why was Fortunato laughing when he was being "walled up"?
Character, plot	I was sure Montresor was just playing a joke on Fortunato.
Character, plot	The narrator makes a big deal about being concerned with Fortunato's health, and asks him several times to leave the catacombs to get away from the damp cellars, not to aggravate Fortunato's cough. Why would he constantly offer to let the man out?
Character, plot	What or why does this man [Montresor] want revenge?
Climax	What is the climax?
God, crisis	The moment of greatest tension is when he is fitting in the last & eleventh final stone in the hole. What is at stake? They say, "For the love of God." Are they going through this for the love of God? What does this line actually refer to? Could it be that God poses a threat to one of these two men?
Irony, Setting	I also think there is some ironic, wry humor concerning Fortunato asking the narrator if he is a mason and the narrator produces a trowel as confirmation. It has occurred to me that such a reference as "supreme madness" of carnival and the ending of the story may leave open the question of whether this tale is an illustration of a mad person.
Luchesi	I don't understand what the character Luchesi has to offer the story....
Luchesi	The narrator is very clever in the way he gets Fortunato to follow him into the vaults. He provides many excuses as to why Fortunato shouldn't necessarily go: too much trouble, he has a cold, [Montresor] has an engagement with Luchesi.
Mason, Character	I wonder if Fortunato was stupid or just too drunk to question "the writing on the wall." Why would Montresor have a trowel under his cloak? Not because he was a "Mason." [This student apparently understood the double entendre.]

Masons	After I read this about 3 times and was writing my first journal it dawned on me that mason in this conversation means two things. Fortunato is talking about a group of people called the Masons, a brotherhood just like there are groups today such as the shriners, or the clan even though they are completely different types of groups, it appears Fortunato is talking about a fighting group the masons. Because again in the beginning of the story, the author tells us he was a strong, respected man. But not a man you could trust. The other kind of mason is the stone mason and the stone mason is what the narrator is.
Masons	I am not sure what the masons/brotherhood had to do with this, but the narrator's production of the trowel reminds me of yet another pun: trowel used for building and masonry.
Masons, irony	One of my favorite elements of irony in the story is when Fortunato asks if Montresor is a mason he is speaking of the brotherhood. [But] When Montresor answers he is speaking of a stone mason since he intends to wall Fortunato up.
Nitre	At the end of the story, "My heart grew sick—on account of the dampness of the catacombs." If nitre seeps through the walls, along with the chill of the air through the walls, [Montresor] could have been feeling pretty bad physically.
Nitre, setting	The nitre on the walls was interesting. I am not sure if I see the connections unless the narrator was trying to tie the explosiveness of the nitre (potassium nitrate used in gunpowder) to the explosiveness of the situation.
Nitre, symbolism	The walls are covered with nitre. There is mention of this several times. I think it symbolizes that Montresor believes that Fortunato "stinks" as a human and is also a "slime."
Plot	Why did they wait 50 years to find the body? [The student mistakenly believes that someone found the body.]
Plot and world knowledge	What was the horrible gesture that Fortunato made in the crypt and what bearing did that have on the story?
Semantic meaning	Impunity was used a lot in the story, but I'm not sure what the meaning is in relationship to the story. Ex. It was used in the introduction and in the motto.
Semantic meaning	What does Poe mean when he says, "A wrong is unredressed when retribution overtakes its redresser"?
Semantic meaning	What exactly did the motto on the coat of arms mean?
Semantic meaning/ world knowledge	What was [a] Mason? Was it a religious group? or the work?
Setting	The story probably takes place during the Renaissance, because the way the author explained what Fortunato was wearing: he was wearing tight-fitting part-striped dress, and he had a conical cap and bells. [The student missed several details which imply the murder occurred in the late 18th century.]
Terminology	Isn't the story dramatic as well as situational irony?

The range illustrated in Table 2 appears to be a function of individual differences; for example, metacognitive sophistication, reading ability, general world knowledge, and field dependence/independence. (For a detailed discussion of the role of individual differences in journal writing, see Cole, 1992.) Through questions or comments, students may try to (a) clarify facts, and allusions, (b) verify inferences about world knowledge or character motivation, (c) apply literary terminology (e.g., identify instances of foreshadowing, irony, the conflict, the crisis, or the climax), (d) analyze or evaluate the various literary elements (e.g., setting, motivation, or point of view), (e) problem solve to identify the theme, or (f) evaluate a story in terms of its subject or theme, its plausibility, its artistic merit, etc. Equally interesting is the fact that while every class of students *as a whole* tends to have similar questions and comments, each class has unique questions and comments that reveal major bugs in their understanding or astute insights. On the one hand, the similarity between groups of students allows the teacher to utilize a general instructional design; on the other hand, the uniqueness requires "on the fly" adjustments to students' needs.

Formative Evaluation

Not all adjustments must occur "on the fly." Instructional design and development can identify some of the questions and comments during traditional formative evaluation, and provide scaffolding, if appropriate, for future learners. For example, formative evaluation which incorporated student journals could certainly have detected the somewhat common misconception that Montresor was just going to play a joke on Fortunato ("I was sure Montresor was just playing a joke on Fortunato") as well as the reason for this misreading. This is one of the misconceptions that derives from students' inferring inaccurate meanings of the word *immolation* (in the opening of the story), rather than taking time to verify the meaning in a dictionary. Although textbook editors usually footnote definitions of a few of the words in that story (e.g., *pipe*, *roquelaire*, *flambeaux*, *In pace requiescat*), they never include *immolation*; yet, clearly, they should.

But again it is important to emphasize that formative evaluation does not stop when instruction is implemented—it is an ongoing process whose purpose is to improve the product. Because each group of students brings its own needs to the learning situation, every group of students is likely to flush out previously undetected errors or limitations of the instruction.

Implications for Instruction and Learning

Respecting a learner's questions and comments encourages exploration; the student's questions and comments can scaffold his/her own learning. Using a vehicle such as journal writing, by which the learner can share questions and comments in a non-threatening context, gives the teacher the opportunity to (a) monitor the student's comprehension; (b) identify misconceptions which interfere with learning, or insights; and (c) in keeping with the goal of empowering the learner, provide just enough help for the learner to complete the task (e.g., Burton & Brown, 1979; Resnick, 1983).

Student-generated questions and comments can scaffold instructional design, development, and implementation by:

(a) facilitating teacher's decomposing his/her expert knowledge,
(b) helping the teacher assess the students' prior knowledge (including misunderstandings),
(c) providing a basis for selecting and sequencing instruction (the teacher is free to choose whatever sequence and method he/she wishes).

Student-generated questions and comments can serve as an instructional tool in the following ways:

(a) individualizing instruction by identifying problems individual students encounter in interpreting instructional materials;

(b) providing specific feedback in a timely and appropriate manner; for example, the teacher can respond in writing in journals, tutor students, or recommend other remedial or enrichment activities;[8]

(c) developing rapport between student and teacher;

(d) motivating students by encouraging them to interact with text on their own levels.

Journal writing can itself facilitate instruction by providing an incentive to read assignments reflectively before class discussion (e.g., Bauso, 1988; Cole, 1992; Schwartz, 1989). If students have not read an assignment, it is, of course, impossible to engage them in meaningful dialogue in class—identifying and addressing misconceptions and going beyond the foundation provided by the text. Without a meaningful incentive for students not only to read assignments but also to read them reflectively, the best laid plans of instructional designers, developers and teachers often go astray. In my research (Cole, 1992), the brightest student described himself as "lazy" and said he would not have thought about an assignment until class discussion unless he had been required to write journals. He said he found journal writing helpful, and even enjoyed it, and recommended requiring journal writing of future students.

Finally, because reading journals is so time-consuming, after they have read journals on a given work from a couple classes teachers might be tempted not to assign future students journals on that work, basing instruction on the questions and comments of former students. Although each class of students *tends* to address the same issues, teachers should resist such temptations. First, each class raises some unique issues. More importantly, one of the major purposes of journal writing is to help each student become an independent learner. Thus instruction must provide extensive practice for each student to develop his/her ability to identify problems and explore solutions.

Although these implications for instruction and learning focus on the teacher and students, formative evaluation allows them just as readily to translate into benefits for designers and developers.

Recommendations

Students' questions and comments have been relatively discounted in the traditional instructional design, development, and implementation process, yet constructivist paradigm as well as empirical evidence suggests that students' questions and comments have important implications for instruction and learning. While research must try to shed light on this issue, I would like to offer a few recommendations for every instructional project (see Cole [1992] for additional recommendations for implementing journal writing):

1. Determine when students' questions and comments can be elicited and addressed in the instructional design, development, and implementation process.

   In theory, it is desirable to include them at every stage, but this may be impracticable. If so, the layers-of-necessity instructional development model (Tessmer & Wedman, 1990; Wedman & Tessmer, 1990) allows for incorporating them in later versions of a project. Implementation should always provide the opportunity for questions and comments.

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[8] In my research (Cole, 1992), several students identified having their questions answered as the most helpful aspect of journal writing. The implications are that class discussion would not have raised those questions and that they would not have asked those questions, even though the students seemed to participate readily in class.

2. Determine how students' questions and comments can and should be elicited and addressed in the instructional design, development, and implementation process.

   What medium should be used (e.g., class discussion, journals, e-mail, manual,...)? The nature of the domain as well as the task influence this issue. For example, if the task is procedural, the student needs an immediate response, especially if injury could result; a journal would be totally inadequate. If the domain is well-defined, a manual or on-line help system might be appropriate. On the other hand, if the domain is ill-defined and/or the task requires reflection, a journal or some type of collaborative learning (e.g., class discussion or electronic bulletin board) would be appropriate.

   The question of "how" is, of course, related to "when." For example, surveys, interviews, debriefings, think-aloud protocols, on-line help systems, and e-mail might be appropriate in formative evaluations.
3. Consider whether it is important to maintain students' anonymity when they ask questions or comment. You might want to provide more than one vehicle for questions and comments—one public (e.g., class discussion, collaborative groups, e-mail), at least one private (e.g., journals shared only with the teacher, an anonymous electronic bulletin board).
4. Create an environment in which students feel "safe" in asking questions and commenting. Be honest but tactful.
5. Clarify the purpose of questions and comments. For example, if you use journals, discuss the purpose in class. Encourage students to ask questions and comment about the purpose, the procedure, grading criteria, etc. at any time during the course.
6. Provide instructional support for question/comment activities and assignments. For example, if you assign journals, model the process in class; provide ungraded practice; give written models; provide live or CAI tutorials on journal writing; etc.
7. To encourage students to question and comment, respond in a timely way.
8. Use grading criteria and feedback which encourage meaningful questions and comments.
   a. Try to achieve a golden mean in grading. Don't grade "tough"—it doesn't encourage students to explore (e.g., Cole, 1992; Roth, 1985). Don't grade "soft"—most students need the external motivator (e.g., Holland, 1989; Roth, 1985), even when they find journal writing helpful.
   b. Be careful about wording of feedback. Try to encourage students to extend their reach. Don't say, "No, this is wrong." You might ask instead how the student accounts for specific details which conflict with the student's interpretation. When you discuss journal questions and comments in class, don't identify the students but do express support for students' trying to make sense of the assignment (even if they have a partial or wrong interpretation). Emphasize that you don't penalize students for making "wrong" comments, being confused, or asking questions that reveal they don't understand the story.
9. As a part of any mid-course or end-of-course evaluations, ask students to evaluate whatever question/comment strategies you utilize; for example: "What did you find most helpful about writing your journal?" "What did you find least helpful about writing your journal?" "How helpful did you find writing your journal?" (Use a Likert scale.) How helpful were job aids on journal writing, such as student examples?

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Title:

A Review of Experimental Studies of Interactive Video Instruction in Oral Communication

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A Review of Experimental Studies of Interactive Video Instruction in Oral Communication

Abstract

This paper reviews experimental research on the pedagogical effects of three IVI programs in oral communication. Formative evaluations indicate that students enjoyed the level-III interactive video instruction (IVI) programs. Results of an immediate posttest, delayed posttest, control group design indicate that the IVI program "Coping with Speech Fright" appears to be as effective on speech fright and recall measures as lecture/linear videotape instruction by two outstanding public speaking instructors. Furthermore, students in the IVI condition achieved significantly higher immediate and delayed cognitive test scores and significantly greater reduction of speech fright over a four-week period than did students in the control group. Results of two separate studies using an immediate posttest, control group, comparison group design indicate that students receiving IVI in "Constructing Speaking Outlines" and "Developing Key Ideas: The Four S's" achieved significantly higher immediate recall/application test scores than did students in the control group or the comparison group. Regression analysis indicated no significant effects of novelty, GPA, IVI feedback rating, IVI video rating, or nature of participation (voluntary versus required) on cognitive test scores of the IVI treatment group in either study.

Recent reviews report significant learning outcomes associated with IVI (Bosco, 1986; DeBloois, 1988; Gayeski & Williams, 1985; Kalowski, 1987; Kearsley & Frost, 1985; McNeil, 1989; Smith, 1987). The most recent review (Fletcher, 1990), which included a meta-analysis of 47 empirical studies of IVI in defense training and related applications in industrial training and higher education, concluded that IVI is more effective and less costly across a variety of instructional settings and objectives than conventional instruction. However, these findings must be interpreted with caution because methodological weaknesses in many of the IVI studies have been identified, including: investigator bias, non-random assignment of subjects, lack of a control group, inadequate definition of instructional treatments, failure to measure the degree to which the treatments were implemented by subjects, artifact, lack of generalizability, and inadequate sampling (Bosco, 1986; Bunderson, Baillio, Olsen, Lipson, & Fisher, 1984; Cushall, Harvey, & Brovey, 1987; Reeves, 1986, 1990; Slee, 1989; Smith, 1987).

Many of the empirical studies considered in these reviews were conducted in the hard sciences. Theorists (Biglan, 1973; Kolb, 1981; Kuhn, 1962; Moses, 1990) have identified significant differences in typical teaching style and typical learning style in the hard sciences (laboratory science and mathematics) as compared to soft skill disciplines (humanities and social sciences). Do the reported pedagogical advantages of IVI apply to the soft skill disciplines? Cronin and Cronin (1992) reviewed 32 post-1984 empirical studies in soft skill areas and concluded that "taken as a whole, these studies appear to indicate that IVI produces significantly greater cognitive and application gains than conventional methods of soft skill instruction" (p. 59). IVI produced significant cognitive or application gains in soft skill areas such as reading, management, study skills, logical reasoning, foreign language, sales training, photography, secondary and special eduction, economics, and art. Furthermore, Cronin and Cronin (1992) concluded that:

1. IVI with videotape produced similar learning outcomes compared to IVI with videodisc.
2. The significant pedagogical advantages of IVI in soft skill areas are not due to (a) novelty effects, (b) superior instructional product in the IVI treatment versus the conventional instruction treatment, or (c)

additional learning time possible with uncontrolled time-on-task in the IVI treatment.

3. IVI may be more effective than conventional instruction in addressing a wide variety of uncontrolled student variables. Most studies reported a lower mean standard deviation on dependent variables for the IVI group than for the comparison group.

4. Recent IVI research in soft skill areas addressed several of the methodological criticisms of earlier research.

> All but two of these studies used a control or comparison group; 48% used 80 or more subjects; and 61% of the studies randomly assigned subjects to treatment groups. However, most studies in this area remain open to the charge of investigator bias because 70% were conducted by the IVI developer(s) or the developing organization. Furthermore, none of these studies treated the subjects' actual implementation of the interactive video instruction available as an independent or a dependent variable.
>
> The most serious methodological weaknesses in the empirical research reviewed have direct relevance to the necessity of developing and testing theories explaining why IVI produces significant learning effects. Researchers failed to describe the IVI treatment in adequate detail in 73% of the empirical studies, making interpretation of findings difficult. Moreover, because no study in this critical synthesis provided a detailed analysis of the video components of IVI, interpretations of the unique video contributions to learning via this medium are impossible. In addition, although some studies measured user attitudes toward the medium, no study that allowed for learner control reported on variations in actual use of the instructional program among users. Interpretations of the relationship between users' attitudes toward IVI and their actual instructional use of the medium are difficult absent such measures. Continued failure to isolate subject differences in the actual use of the instructional program and to provide detailed analysis of the video components of IVI make it difficult to integrate the empirical research into any comprehensive

theory. (Cronin & Cronin, 1992, p. 69)

Although IVI in soft skill areas appears to offer significant instructional benefits in cognitive achievement, transfer of learning to performance, motivation to learn, student achievement across uncontrolled student characteristics, user acceptance of the technology, and time required to achieve content mastery; do these outcomes apply for IVI in oral communication? The remainder of this paper summarizes experimental studies of the pedagogical effects of IVI in "Coping with Speech Fright," "Constructing Speaking Outlines," and "Developing Key Ideas: The Four S's."

"COPING WITH SPEECH FRIGHT"[1]

Recent research indicated that approximately seventy percent of the population experiences moderately high or high communication apprehension in public speaking contexts (Richmond & McCroskey, 1989). High levels of communication apprehension have negative consequences in the speech-making process such as: communication avoidance (Beatty, 1987; Mulac & Wiemann, 1984); shorter speeches (Beatty, Forst, & Stewart, 1986); lower self-esteem, less effective public communication (Daly & Stafford, 1984); less effective preparation for public speaking, increased perceptions of failure in speaking (Kelly, 1984); increased disfluencies, less effective nonverbal communication while speaking in public (McCroskey, 1982); more frequent decision-making errors in constructing a speech (Beatty, 1988); and considerable anxiety in those with high levels of communication apprehension if they are forced to communicate (Beatty, 1987).

Most institutions have too few speech faculty competent to provide traditional instruction in coping with communication apprehension to such a large population (Ayres & Hopf, 1987). Interactive video instruction (IVI) is capable of providing effective training to large numbers of students in a cost-effective manner.

Research Hypotheses

This investigation involved a control group which received no formal instruction in overcoming speech fright, an IVI group, and a group which received lecture/linear videotape instruction by outstanding teachers in cognitive restructuring techniques to cope with speech fright. Because the content of the lecture/linear videotape version of the lesson was virtually identical to the IVI and because only outstanding instructors were used to present the lecture/linear videotape version in this study, no significant differences on cognitive gains between treatment groups were predicted. However, given the educational advantages of IVI discussed previously:

H1: Students using IVI will achieve significantly higher cognitive test scores immediately after treatment than will students in the control group.

H2: Students using IVI will achieve significantly higher cognitive test scores four weeks after treatment than will students in the control group.

After receiving IVI, students in all conditions presented at least one graded speech before completing the delayed-test instruments. Because students trained over a substantial time period in cognitive restructuring techniques and given opportunities to practice them showed significant reductions in communication apprehension (Connell & Borden, 1987; Harris, 1980), we expected:

H3: Students using IVI will achieve significantly greater reduction in speech fright over a four-week period than will students in the control group.

Method

Subjects. After adjusting for student absences and failures to follow directions, 138 college students enrolled in introductory public speaking classes at a middle-sized, comprehensive university in the southeast region served as subjects. Male subjects comprised 48% of the sample and female subjects made up 52%. Students received no extra course credit for participation in the study.

Instructional Materials. Two parallel forms of the lesson were developed, a lecture/linear videotape and a level-III interactive videotape version. The multimedia IVI module incorporates a tutorial/simulation approach. It includes carefully designed orienting activities, questions, feedback, and review options to promote understanding. A user-friendly design facilitates student use by explaining the nature of IVI, instructing students in program use, and repeating specific instructions for use of each screen requiring student reaction.

The multimedia approach promotes interest and understanding through humorous graphics, visual memory cues, and workbook exercises designed to enable students to apply IVI learning to their specific problems of speech fright. Video adapted to the target audience includes examples of speakers experiencing speech fright, testimonies of those who suffer from speech fright, examples of students' negative self-evaluation, trainer-led exercises and simulations for developing positive self-evaluation, and a brief analysis of other techniques for coping with speech fright.

The IVI program provides a carefully constructed combination of learner-control of major topics to be explored (i.e., the nature of speech fright, how to overcome speech fright, and nonverbal indicators of speech fright) with program-control of IVI within each major topic. This allows learners to focus on topics that interest them and ensures that they will follow the lesson sequence developed by experts in instructional design for each topic selected (Canelos, Baker, Taylor, Belland, & Dwyer, 1986).

Procedures and Design. An immediate posttest, delayed posttest, control group design was used for this study. The independent variable consisted of the videotape-based instructional materials with two levels (interactive videotape vs. lecture/linear videotape). The dependent variables included immediate and delayed cognitive test scores, immediate and delayed scores on the public speaking section of the Communication Apprehension in Generalized Contexts instrument, and immediate responses on the formative evaluations by the treatment groups.

Students in intact public speaking classes, most of whom had not received any instruction in reducing speech fright, served as the control group. In an attempt to avoid a Hawthorne-type effect, students in the control group received a 45-minute placebo lecture on public speaking techniques unrelated to coping with speech fright.

Students in the treatment groups, most of whom had not received any instruction in reducing speech fright, were randomly assigned to IVI or lecture/linear video (LLV) treatments. Treatments were conducted during the second week of the Spring 1991 semester. The 45-minute LLV treatment was presented in three classes by the assigned instructor to groups of eight to ten students in a classroom equipped for videotape playback. Both instructors received outstanding teaching ratings from the department chair and averaged 4.5 out of 5 on their most recent student evaluations. The instructional content of the LLV was virtually identical to the IVI version and included almost all the video included in the IVI condition. However, this video was presented as linear video.

IVI users received an average of 46 minutes of individual instruction in a small private laboratory room. This condition included the opportunity to complete workbook exercises but did not require completion of these exercises, provided no opportunity for class discussion, and did not require students to be exposed to all the content instruction.

Students completed a ten-item test of cognitive recall (test-retest reliability = .693) and the CAGC-PS (test-retest reliability = .702) immediately after they received the instructional material. They completed Form B of the recall test and the CAGC-PS (Richmond & McCroskey, 1989) four weeks later.

Results

Cognitive Test--Immediate. The results supported hypothesis 1, which predicted that students using IVI would achieve significantly higher cognitive test scores immediately after treatment than would students in the control group. There was no significant difference between the mean immediate cognitive test scores of students in the IVI and the LLV conditions. The maximum possible score on the cognitive test was 10. The mean score was 8.63 for students in the IVI condition, 8.37 in the LLV condition, and 7.10 in the control group. ANOVA results showed significant differences among the mean immediate cognitive test scores of subjects in the three groups ($\underline{R}^2 = .26$, $\underline{F}$ [2, 135] = 23.92, $\underline{p} < .0001$). The group differences accounted for 26% of the variance.

Cognitive Test--Delayed. The results supported hypothesis 2, which predicted that students using IVI would achieve significantly higher cognitive scores four weeks after the treatment than would students in the control group. There was no significant difference between the mean delayed cognitive test scores of students in the IVI and LLV conditions. The maximum possible score on this cognitive test was 10. The mean score was 7.77 for students in the IVI condition, 7.26 in the LLV condition, and 6.22 in the control group. ANOVA results showed significant differences among the mean delayed cognitive test scores of subjects in the three groups ($\underline{R}^2 = .22$, $\underline{F}$ [2, 135] = 18.70, $\underline{p} < .0001$).

The group differences accounted for 22% of the variance.

Communication Apprehension Test Scores. The results supported hypothesis 3, which predicted significantly greater reduction in speech fright over a four-week period for students in the IVI treatment than in the control group. Students in the IVI condition showed a mean reduction in speech fright of .866 points over the four-week period, while students in the control condition showed a mean increase in speech fright of .876 points. An independent t-test indicated that these mean change scores were significantly different (t [70.5] = -1.81, $p < .04$). There were no significant differences between the CAGC-PS scores of students in the IVI and LLV treatment groups on either immediate or delayed measures.

Educational Implications

Discussion of implications relevant to all three studies of IVI in oral communication will be presented in the final section of this paper. Only implications unique to each separate study will be discussed in these subsections.

The finding of no significant differences between the IVI and LLV treatments may encourage educators to investigate innovative applications of IVI in "Coping with Speech Fright." The use of individualized self-paced IVI to train large numbers of students may be at least as effective, and perhaps more effective and less costly across a wide variety of instructional settings and objectives than conventional instruction (Fletcher, 1990).

A review of previous research comparing IVI and LLV in soft skill areas concluded that "IVI appears to produce significantly greater recall or application of learning than linear video instruction" (Cronin & Cronin, 1992, p. 59). Although the findings of this study appear to be at variance with this conclusion, most previous studies failed to control for the quality of the instructor or the quality of the instructional products compared. The time and talent devoted to developing IVI may produce an instructional product superior to a less thoroughly prepared product by an instructor using LLV. The combination of outstanding instructors, virtually identical instructional content, and the careful preparation of the LLV lesson may explain its comparability to the IVI treatment in significantly enhancing learning.

Given the demonstrated success of the IVI program in cognitive instruction, the CAGC-PS scores of students in the IVI and control conditions may show even more significant differences if compared over a longer period of time. Cognitive restructuring training requires substantial time and speaking practice for students to apply these techniques to reduce their specific fears. The absence of instructor-led practice in applying cognitive restructuring techniques to public speaking performance, while helpful to the integrity of the research design, reduces the likelihood of producing significant effects on speech fright.

A follow-up analysis of the results of this study compared cognitive test scores and the actual use of IVI by subjects. Major variations among subjects' time-on-task on the IVI program occurred in section I (The Nature of Speech Fright) and section II (Cognitive Modification Techniques to Cope with Speech Fright). Subjects (n = 14) who spent no time on section I scored slightly higher on cognitive tests (immediate M = 8.8, delayed M = 7.9) than subjects (n = 16) who spent time on that section (immediate M = 8.5, delayed M = 7.7). Likewise, subjects (n = 10) who spent less than 10 minutes on section II scored about the same on cognitive tests (immediate M = 8.6, delayed M = 7.7) as subjects (n = 20) who spent more than 10 minutes on that section (immediate M = 8.6, delayed M = 7.8).

Major variations in time spent on sections I and II of the IVI program did not result in significant differences on immediate or delayed cognitive test scores. Subjects using the "Coping with Speech Fright" IVI appeared to demonstrate appropriate judgements regarding what material they needed to study and how much time they needed to spend on "branches" of the IVI program.

"CONSTRUCTING SPEAKING OUTLINES"[2]

Theoretical Perspectives

Research, though limited, generally supports the conclusion that effective organization of an oral message increases recall, attitude change, and speaker credibility ratings (Daniels & Whitman, 1981; McCroskey & Mehrley, 1969; Thompson, 1967; Whitman & Timmis, 1975). The authors of current public speaking textbooks view outlining as critical to the organization process. A survey of recent public speaking texts reveals that organization is seen as a key to speaker success and outlines are seen as the key to organization (e.g., Sprague & Stuart, 1988; Sproule, 1991, Verderber, 1991).

Research Hypotheses

Given the educational advantages of IVI discussed previously:

H1: Students using IVI in "Constructing Speaking Outlines" will achieve significantly higher cognitive test scores immediately after treatment than will students in the control group.

H2: Students using IVI in "Constructing Speaking Outlines" will achieve significantly higher cognitive test scores than will students in the comparison group.

No previous study has investigated the effects of voluntary versus required participation in IVI. High willingness-to-communicate subjects are significantly more willing to agree to participate and significantly more likely to participate in communication research studies than low willingness-to-communicate subjects (Zakahi & McCroskey, 1989). Thus, volunteer subjects in communication research are likely to exhibit higher willingness-to-communicate than students who are required to participate. Furthermore, volunteer subjects are likely to be more accepting of IVI than non-volunteer participants and thus may be more motivated to learn from the IVI.

H3: Volunteer subjects receiving IVI will achieve significantly higher cognitive test scores immediately after treatment than will subjects required to use IVI.

Several theorists assert an alternative hypothesis for the reported pedagogical effects of IVI, namely; the novelty effect of IVI may produce higher initial motivation to learn (Clark & Sugrue, 1988; Hannafin, 1985; Slee, 1989). However, a critical synthesis of IVI research in soft skill areas identified several studies that controlled for novelty effects and reported significant pedagogical effects for IVI (Cronin & Cronin, 1992). Furthermore, the only reported experimental study of IVI in speech communication found no significant novelty effect for IVI on immediate or delayed cognitive test scores. Neither preference for IVI over traditional instruction nor previous use of other IVI modules versus first-time use showed a significant association with cognitive test scores (Cronin, Grice, & Olsen, 1992).

H4: There will be no association between treatment group subjects' preferences for IVI versus traditional instruction and their cognitive test scores immediately after treatment.

H5: There will be no association between treatment group subjects' previous use of other IVI modules and their cognitive test scores immediately after treatment.

The self-paced individualized instruction available in IVI may be more effective than traditional instruction for low-prior-achievement users. Savenye and Strand (1989) reported that the average student using IVI in physical science instruction demonstrated higher achievement levels than the average student receiving traditional physical science instruction. This difference was even more pronounced for students of lower prior achievement. Furthermore, research on application-intensive IVI similar to that used in this investigation found either no significant difference on immediate posttests between high-prior achievers and low-prior achievers using IVI (Dalton, 1986; Gray, 1987) or a significant prior achievement x treatment interaction (Schaffer & Hannafin, 1986). Students with high GPAs generally surpass students with low GPAs on cognitive tests on instructional material. However, IVI may help close the cognitive-gain gap between students with lower academic achievement and students with higher GPAs.

H6: There will be no association between treatment group subjects' reported grade point averages and their cognitive test scores immediately after treatment.

Method

Subjects. After adjusting for student absences and failures to follow directions, 141 college students at a middle-sized, comprehensive university in the southeast region served as subjects. Male subjects comprised 51% of the sample and female subjects made up 49%.

Instructional Materials. The multimedia approach promotes interest and understanding through humorous graphics, visual memory cues, dual screen and dual channel presentations, and exercises designed to enable students to apply IVI learning to the construction of speaking outlines. Examples of the multimedia design features are provided below.

Graphics, voice overs coordinated with text summaries, and a friendly "tutor" are incorporated to illustrate key principles and to enhance motivation to learn. The graphics include putting the tips for designing speaking notes on separate notecards to highlight the tips and to illustrate the use of notecards in a speech. Other graphics serve as mnemonic devices for the user. One graphic uses a combination of large and small submarines to illustrate the relationship of subpoints to main points. The idea being that subpoints are subordinate to main points just as the small submarines are arranged under the large submarines. A related graphic identifies types of oranges under a visual of an orange and types of apples under a visual of an apple. Thus, graphically illustrating the outlining principles that subpoints must be related to main points and that main points should be mutually exclusive.

The program also incorporates simultaneous display on two screens and voice overs combined with text summaries. Two-screen or two-channel display in IVI provides two major pedagogical advantages. First, these dual options allow the user to become the editor of the program. The user can decide whether to listen intently to the voice over, to listen while reading the summary, to try to tie in the graphic with the text, or to integrate all of these elements. This editing option allows users to adapt the IVI program to their learning styles. Secondly, the simultaneous use of several interactive channels adapts to the modern TV, remote control, stimulus-load expectations of users. The stimulus load may be a necessary adaptation to the media expectations of users accustomed to the quick-cutting images of modern music videos, commercials, and movies, as well as routine "channel hopping."

Procedures and Design. An immediate posttest, control group, comparison group design was used for this study. The independent variable consisted of the presence or absence of videodisc-based IVI on "Constructing Speaking Outlines." The dependent variables included immediate cognitive test scores and treatment group responses on the formative evaluations. Analysis of variance (ANOVA) was used to analyze the cognitive test scores among the treatment, control, and comparison groups. Following a significant $\underline{F}$, Duncan's Multiple Range Test was used to determine significant differences among individual group means. Regression analysis was used to analyze the cognitive test scores of the treatment group with the nature of participation (required versus voluntary) and S's rating of feedback in the IVI program, rating of the video in the IVI program, reported grade point average, previous use of

IVI on other topics, computer skills estimate, and preference for IVI compared to traditional classroom instruction serving as predictor variables.

Students from non-speech classes in economics, political science, health, and marketing either volunteered or were required to undergo IVI. They were randomly assigned to the treatment or the control group. These subjects received neither instruction in constructing speaking outlines in class prior to the study nor extra credit for their participation in this study. In an attempt to avoid a Hawthorne-type effect, students in the control group received approximately 30 minutes of placebo IVI in "Developing Key Ideas: The Four S's." This instruction provided no information on constructing speaking outlines. The control group consisted of 25 males and 22 females, 24 volunteered and 23 were required to participate.

The treatment group received approximately 35 minutes of IVI in "Constructing Speaking Outlines." The treatment group consisted of 24 males and 20 females, 24 volunteered and 20 were required to participate. These ratios were virtually identical to those in the control group.

The comparison group consisted of 50 students from three intact performance classes in speech (two in public speaking and one in argumentation and debate) who had received "normal" instruction, practice, and feedback on constructing speaking outlines. The comparison group was included to compare learning outcomes from IVI in constructing speaking outlines with the usual instruction on this topic provided in these speech classes.

The study was conducted between November 12 and 26, 1991. Participants in both the treatment and control conditions were shown how to use the IVI program by a trained student worker and were left alone to complete the lesson. Students in both treatment and control groups completed a sixteen-item test on constructing speaking outlines (split-half reliability = .89), a sixteen-item test on developing key ideas, and a formative evaluation of the instruction immediately after they received the instructional material. Students in the comparison group completed both sixteen-item tests during a regularly scheduled class. These measures were randomly ordered and randomly assigned in all groups to control for an order effect.

Results

ANOVA results supported hypothesis 1, which predicted that students using IVI on constructing speaking outlines would achieve significantly higher cognitive test scores immediately after treatment than would students in the control group. ANOVA results also supported hypothesis 2, which predicted that students using IVI on constructing speaking outlines would achieve significantly higher cognitive test scores than would students in the comparison group. The maximum possible score on the cognitive test was 16. The mean score was 10.72 for volunteer participants in the treatment group, 10.21 for required participants in the treatment group, 7.82 for required participants in the control group, 7.76 for volunteer participants in the control group, and 7.62 for participants in the comparison group. These scores were significantly different ($\underline{R}^2 = .30$, $\underline{F} = [4, 136] = 14.72$, $\underline{p} < .0001$). The group differences accounted for 30% of the variance.

Regression analysis did not support hypothesis 3 that volunteer participants would achieve significantly higher cognitive test scores immediately after treatment than would subjects required to participate. The mean cognitive test scores in the treatment group for volunteers ($\underline{M} = 10.72$) and required participants ($\underline{M} = 10.21$) were not significantly different ($\underline{F}$ [2, 41] = .61, $\underline{p} < .4382$). The addition of this predictor variable to the regression model increased the $\underline{R}^2$ by only .014 (see Table 1).

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Insert Table 1 about here

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Regression analysis indicated that, as hypothesized (4 and 5), there was no significant novelty effect on cognitive test scores in the treatment group. No significant association was found between immediate cognitive scores in the IVI treatment and variations in subjects' previous use of other IVI modules ($\underline{R}^2 = .05$, $\underline{F}$ [1, 42] = 2.23, $\underline{p} < .1432$). Likewise, there was no significant association between immediate test scores and variations in preference for IVI versus conventional instruction ($\underline{F}$ [7, 36] = .10, $\underline{p} < .7582$). The addition of this predictor variable to the regression model increased the $\underline{R}^2$ by only .002 (see Table 1).

Regression analysis supported hypothesis 6 that there would be no significant association between variations in GPA and cognitive test scores immediately after treatment. There was no significant association between variations in GPA and cognitive test scores in the IVI treatment group ($\underline{F}$ [4, 39] = .26, $\underline{p} < .6158$). The addition of this predictor variable to the regression model increased the $\underline{R}^2$ by only .006 (see Table 1).

Educational Implications

IVI may enhance the effectiveness of video by facilitating active discovery and application on the part of the learner (Hamilton & Taylor, in press; Hansen, 1989). Students reported that the video portion of the IVI was helpful in promoting understanding of the material and made the IVI more enjoyable and more interesting. However, scores on this three-item measure of the pedagogical effectiveness of the video portion of the IVI ($\underline{M}$ = 1.87, $\underline{SD}$ = .64, Cronbach's α = .48) showed no significant relationship with students' cognitive test scores. More precise descriptions of the nature and functions of the video portions of IVI, more reliable self-report measures, and measurements of students' actual use of the video options would promote theory building and theory testing.

Feedback constructs developed in the communication discipline may be helpful in designing IVI and explaining empirical results. Positive feedback from a highly credible source and feedback that is perceived as informative (versus controlling) produces increased internal motivation (Cusella, 1980). Most students reported that the feedback in the IVI program was believable, informative, and did not attempt to control their behavior regarding constructing speaking outlines. However, the reliability of the three-item additive index of students' perceptions of the pedagogical effectiveness of the feedback in the IVI program was so low ($\underline{M}$ = 2.04, $\underline{SD}$ = .56, Cronbach's α = .12) that no definite conclusions can be drawn regarding contributions of IVI feedback to learning. More reliable measures of the various, and perhaps distinct, functions of feedback in IVI; more precise descriptions of the nature and functions of the feedback design in IVI; and measurements of students' actual use of the feedback options would promote theory building and theory testing.

"DEVELOPING KEY IDEAS: THE FOUR S's"

This study was conducted concurrent with the "Constructing Speaking Outlines" study. The theoretical perspectives were similar in exploring the effects of organization in oral communication. However, this study focused on the organization of key ideas via signposting, stating, supporting, and summarizing each key idea. Except for substituting "developing key ideas" for "constructing speaking outlines," the research hypotheses, educational implications, and the method were identical to those described in the "Constructing Speaking Outline" study with three exceptions. (1) The split-half reliability of the cognitive/application test in this study was .891 and Cronbach's α for the three-item measures of the pedagogical effectiveness of the video portion and the feedback portion of the IVI were .65 and .68 respectively. (2) The instructional material provides a tutorial approach in this multimedia IVI module. It includes carefully designed orienting activities, questions, feedback, graphics, video simulations, and review options to promote understanding. A user-friendly design facilitates student use by explaining the nature of IVI, instructing students in program use, and repeating specific instructions for use of each screen requiring student reaction. (3) The subjects in the treatment group in this study served as the subjects in the control group in the "Constructing Speaking Outlines" study and vice versa.

Results

ANOVA results supported hypothesis 1, which predicted that students using IVI on developing key ideas would achieve significantly higher cognitive test scores immediately after treatment than would students in the control group. ANOVA results also supported hypothesis 2, which predicted that students using IVI on developing key ideas would achieve significantly higher cognitive test scores than would students in the comparison group. The maximum possible score on the cognitive test was 16. The mean score was 13.96 for volunteer participants in the treatment group, 13.14 for required participants in the treatment group, 4.95 for required participants in the control group, 4.96 for volunteer participants in the control group, and 7.27 for participants in the comparison group. These scores were significantly different (R^2 = .60, F = [4, 138] = 51.75, $p < .0001$). The group differences accounted for 60% of the variance.

Regression analysis results did not support hypothesis 3 that volunteer participants would achieve significantly higher cognitive test scores immediately after treatment than would subjects required to participate (see Table 2). The mean cognitive test scores in the treatment group for volunteers (M = 13.96) and required participants (M = 13.14) were not significantly different (F [1, 43] = 1.56, $p < .219$).

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Insert Table 2 about here

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Regression analysis indicated that, as hypothesized (4 and 5), there was no significant novelty effect on cognitive test scores in the treatment group. No significant association was found between immediate cognitive scores in the IVI treatment and variations in subjects' previous use of other IVI modules ($R^2 = .07$, F [5, 39] = .10, $p < .756$). The addition of this predictor variable to the regression model increased the R^2 by only .002 (see Table 2). Likewise, there was no significant association between immediate test scores and variations in preference for IVI versus conventional instruction (F [7, 37] = .00, $p < .979$). The addition of this predictor variable to the regression model increased the R^2 by .000 (see Table 2).

Regression analysis results supported hypothesis 6 that there would be no significant association between variations in GPA and cognitive test scores immediately after treatment. There was no significant association between variations in GPA and cognitive test scores in the IVI treatment group (F [3, 41] = .47, $p < .495$). The addition of this predictor variable to the regression model increased the R^2 by only .011 (see Table 2).

GENERAL EDUCATIONAL IMPLICATIONS

The apparent efficacy of IVI in significantly enhancing subjects' learning of oral communication techniques in each of the three studies is consistent with research on the effects of IVI in related soft skill areas (Cronin & Cronin, 1992). This finding appears to indicate that a well-designed IVI program can prove effective in training students in oral communication.

The formative evaluations conducted in each of the three studies indicate that IVI users appeared to be highly motivated to learn from the medium. Most users found the IVI programs interesting and enjoyable and wanted to learn more about oral communication after taking the training. IVI users felt that they would be capable of using the training to improve their oral communication competency. Likewise, none of the IVI subjects found it difficult to use the programs. This finding may reinforce the results of a recent study (Cennamo, Savenye, & Smith, 1991) in which undergraduate students perceived that it was significantly easier to learn from IVI than from instructional television and television.

The speaking outline and developing key ideas studies found no significant effects of GPA, IVI feedback rating, IVI video rating, or nature of participation (voluntary versus required) on cognitive test scores in the IVI treatment groups. Furthermore, the most plausible competing hypotheses did not appear to explain results in these studies. Time-on-task and instructional content were equivalent for the IVI and lecture/linear video groups in the speech fright study which reported that IVI was as effective as instruction from outstanding teachers. The novelty effect associated with IVI (Clark & Sugrue, 1988; Hannafin, 1985; Slee, 1989) did not appear to explain results in any of the three studies.

Perhaps the most important outcome of these studies is the preliminary empirical documentation of the instructional effectiveness of IVI in oral communication. Prior to these studies, very little research supporting applications of IVI in oral communication was available.

NOTES

[1] Material in this section is taken from Cronin, Grice, and Olsen (1992).

[2] Material in this section is taken from Cronin (1992, November).

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TABLE 1

"Constructing Speaking Outlines" Treatment Group Increments to R^2 and p for Each Predictor Variable

Variable	R^2	Increment	F	df	SE	p
Previous use of IVI	.0503	---	2.23	1, 42	.279	.143
Required vs. voluntary	.0643	.014	1.41	2, 41	.548	.256
Feedback rating	.0755	.011	1.09	3, 40	.754	.364
Reported GPA	.0816	.006	.87	4, 39	.651	.492
Computer competence	.0880	.006	.73	5, 38	.273	.602
Video rating	.0946	.006	.64	6, 37	.683	.693
Preference for IVI	.0970	.002	.55	7, 36	.287	.788

TABLE 2

"Developing Key Ideas: The Four S's" Treatment Group Increments to R^2 and p for Each Predictor Variable

Variable	R^2	Increment	F	df	SE	p
Required vs. voluntary	.0349	---	1.56	1, 43	.569	.219
Video rating	.0557	.0208	.93	2, 42	.568	.342
Reported GPA	.0665	.0108	.47	3, 41	.611	.495
Computer competence	.0716	.0051	.22	4, 40	.255	.642
Previous use of IVI	.0739	.0023	.10	5, 39	.233	.756
Feedback rating	.0742	.0003	.01	6, 38	.544	.918
Preference for IVI	.0742	.0000	.00	7, 37	.350	.979

Title:

Technology Implementation in Two Restructuring Schools: Past, Present, and Future

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Abstract

The role of technology in two restructuring schools is investigated in light of past, present, and future implementations. The schools have been involved in restructuring for two years and are collaborating with nearby West Virginia University in that movement. Questionnaires, teacher interviews, and classroom observations were used to collect data. Results showed the most common former uses of technology included posters, bulletin boards, filmstrips, and overhead transparencies; today,videos and computers are used to a greater extent. Future plans include networking computers and the acquisition of peripherals for whole-class viewing of computer information. Faculty and administrators believe that technology is a vital part of the restructuring movement, but it is only a tool to be used in the teacher's repertoire.

Technology Implementation in Two Restructuring Schools: Past, Present, and Future

West Virginia University and the Claude Worthington Benedum Foundation have joined forces to aid the restructuring movement in six professional development schools (PDS) near the Morgantown, West Virginia area. Commonly known as the Benedum Project, it is a collaborative educational reform effort in West Virginia involving over 300 public school teachers, principals, and superintendents, along with 115 West Virginia University faculty members. The purpose is to create a new vision for schools and teacher education based on the best research and practice available. New ways of thinking about teaching and administration are being developed to keep in touch with the needs of today's society. Classroom practices include innovative ways of producing students who think critically and creatively. Because technology has become so pervasive in our world, its use has become an important inclusion in classroom instruction. This paper[1] reports the efforts of two PDS sites, Morgantown High School and East Dale Elementary, in reforming the educational process with particular emphasis on the implementation of technology to keep in step with the goals of society. For the purposes of this study, technology is defined as facilities, equipment, and instructional resources used in educational settings.

Review of Literature

In the past, technology implementation in school reforms meant adding new technology to the traditionally structured classroom. At times, when used for seat work, drill-and-practice, or as an add-on, it did nothing more than reinforce passive learning. New tools and techniques will be needed for restructuring to succeed on a large scale. Sheingold (1991) feels that the most serious challenge for restructuring efforts will be addressed by changing *what* and *how* students learn in school. She continues by saying it is unlikely that ambitious goals for learning and teaching can be met without widespread, creative, and well-integrated uses of technologies of many kinds.

If the purpose of education is to prepare us for life in the world, then the technology that is already being utilized in the world should be made available to the students. Because technology is more pervasive in the world outside the classroom, it is now more legitimized for use in the school. As Sheingold (1991) clearly points out, "authentic and legitimate work, work that has real connection to the world outside school, is likely to be engaging and memorable, precisely because it does matter" (p. 19).

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[1] The research reported in this paper was supported by a grant from the Claude Worthington Benedum Foundation.

Collins (1991) has done extensive research in computer use in the classroom. He finds three distinct areas of classroom computer application: (a) computers used as tools (word processing, programming skills, networking in lab settings, spreadsheets, and data base applications); (b) computers used as integrated learning systems (exercises, and students portfolios); and (c) computers used as activity/teaching units (simulations, games, and intellectual motivation uses).

When technology is applied and implemented as part of restructuring, it becomes active, hands-on, student-centered learning (Kell, Harvey, & Drexler, 1990). Restructuring and technology function in tandem, each reinforcing the other. Technology alone will not solve all of the educational problems; it must be integrated with the curriculum to improve teaching/learning, problem-solving skills, and enhance critical, creative thinking

Technology in the classroom is not without problems. Ray (1991) states that the majority of today's educators do not understand the how's, why's, and what's of technology. They recognize a need to receive more information and training, but there is often not enough time or financial support as well as instructional materials needed to do so. Many students have to share computers and, in some cases, classes are held in labs that are minimally equipped. When technology is utilized, it is sometimes done so without a real purpose, intent, or goal. It seems to provide schools the opportunity to say they are technologically in step. Other problems include how to handle non-functional materials and down-time while the hardware is in repair; the organization of restructuring; and technology utilization sometimes so poorly conceived that directions and goals are unclear or not even stated.

Other barriers to technology utilization include: (a) lack of funds to purchase hardware and software; (b) time to prepare the integration of technology into the teaching/learning process; (c) time needed to finalize goals and projects for utilizing technology and in renovating facilities to accommodate hardware; (d) users anticipating more powerful computers and other hardware; (e) facilities experiencing installation problems; and (f) downtime of networks (Falk, 1992).

Summary

Reform efforts are not new, but the current restructuring effort is unique in its way of dealing with revision. Teaching methodologies are changing because of the atmosphere created by the new approach to education as seen in restructuring schools. The information age in which we live almost necessitates that students know where and how to find what they need to know to succeed in life. Students are being taught to be critical thinkers, seeking out information from many sources in a variety of ways. Technology is one of those ways being applied in the classroom as a ramification of what is present in the "real" world.

The Benedum Project is now in its third year of coordinating collaborative efforts between West Virginia University and the participating public schools. Stated goals of improving education in both public and higher education practices are met in various ways which include the use of technology in classroom instruction and management to reflect today's societal needs. The two schools described in this study were chosen because of their exemplary use of technology in restructuring efforts.

Purpose of the Study

The purpose of this study is to determine the role of technology in the restructuring movement in schools.

Research Questions

The specific research questions of this investigation are: (1) What technology is being used in two restructuring schools and how is it being implemented? (2) How was technology implemented prior to restructuring? and (3) What are the future plans for technology acquisition and implementation?

Study 1: East Dale Elementary School
Design of the Study

Sample

Described as a rural school by virtue of its population, East Dale Elementary school is located in northern West Virginia. It is comprised of 644 students from first through sixth grade with 38 teachers, one principal, and one vice principal collaborating to direct educational activities. The average class size is 24 students. Kindergarten students are located in another building, but are often transported to the school for events.

Method

Information was gathered through questionnaires completed by teachers and administrators; three teacher interviews; and videotaping classroom activities. East Dale Elementary was identified as a PDS site with a high use of technology through the recommendation of the Assistant to the Director of the Benedum Project at West Virginia University.

Data from questionnaires were collected in October, far enough into the school year for teachers to be beyond the beginning-of-school activities, yet fully acquainted with technology plans for their classrooms. Videotaping and interviews took place in October and November for the same reasons.

Procedures

Questionnaires relating to the past, present, and future uses of technology were distributed to 38 teachers and two administrators at a faculty meeting by the principal with a request to return them in two weeks. Twenty of these were completed for a 50% return rate. Quantifiable data from the questionnaires were entered into a database and analyzed for comparative information. Semi-structured interviews were held with three teachers who were recommended by the principal as being highly involved with technology. The interviews, approximately 20 minutes long, were audio-tape recorded and transcribed. During one day of classroom observations, 35-millimeter slide photographs and videotape of students using technology were taken. Journal notes of those activities were also recorded.

Analysis

To answer the research question of what technology is being used in this restructuring school and how it is being implemented, transcriptions of teacher interviews were read several times; results of database information gathered from teacher questionnaires were categorized and transformed into graphical representations; and journal notes from classroom observations were studied.

To answer the research question of how technology was implemented prior to restructuring, data from teacher questionnaires were extracted and graphically represented, transcriptions of teacher interviews were reviewed and information relating to the use of technology was retrieved.

To answer the research question of what future plans are for technology acquisition and implementation, teacher questionnaires were scrutinized and transcriptions of teacher interviews were studied.

Results

Descriptive Overview

In 1987, East Dale was chosen as one of only 130 schools nationwide to be named a National School of Excellence, an honor bestowed by the Department of Education in Washington, D. C., after careful scrutiny from federal observers. A prerequisite to this distinction was being named a West Virginia School of Excellence.

East Dale's restructuring movement is based on a vision of education in which, collaborating with higher education, the community, teacher, staff, and students, the plan is to integrate knowledge and critical thinking to develop the whole learner. The school's stated educational goal is to motivate students to value education and become responsible decision makers and life-long learners. Their goal for the use of technology is to expand all learners' knowledge of current and future uses of technology.

Rather than the traditional classrooms with rigid walls as barriers, some of East Dale's classes are arranged into "Clusters" in large areas for instructional purposes. Cluster 100 includes students from Grade 2 and part of Grade 3; Cluster 200 has students in Grade 1 and part of Grade 2; Cluster 300 students are from part of Grade 3 and Grade 4; and Cluster 400 is made up of students in Grades 5 and 6. The areas are open, and the students are separated into groups, but they do contain the usual classroom equipment of tables, chairs, teacher's desk, and books. Five teachers share all resources in the Cluster.

The data collection showed that East Dale Elementary School has an abundance of technology in use. Four general areas of use surfaced and include: (1) Clusters, (2) Computer Lab, (3) Technology Site, and (4) Science Lab. Other departments such as the Library and the Gifted program have technology in place.

Clusters. Cluster 100 (Grade 2 and part of Grade 3) has six Apple computers for student use with content-area and enrichment software. Future plans include networking IBM computers with Cluster 200 in order to use software installed on that network. Cluster 200 (Grade 1 and part of Grade 2) has a network of 16 IBM computers with which students use software for mathematics, language arts, spelling, basic skills, and write their own stories with a desktop publishing program.

In Cluster 300 (part of Grade 3 and Grade 4) there are 12 IBM PCJunior computers. The software used is for word processing, keyboard skills, and as a reinforcer for math instruction. Cluster 400 students (Grades 5 and 6) are sent to the Computer Lab in a separate room for instruction in computer skills.

Computer Lab. The Computer Lab at East Dale has been in existence for several years. The IBM PCJunior computers, now housed in Cluster 300, were previously situated in this location. This year, 15 IBM Model 2 computers are used by fifth and sixth graders learning keyboard skills and word processing. One day a week they have their choice of math, geography, or spelling software to use. The students are paired for 20-minute work sessions for each partner in a 40-minute period every day.

The director is completing her first year of teaching in the computer lab and had to arrange and coordinate all equipment and activities for her students. She also offers informal help to any teacher requesting it. Plans are in the making for fund-raising activities to purchase an overhead projector and LCD pad for whole-class viewing. Networking with other computers in the school is a possibility sometime in the future.

Technology Demonstration Site. Fifth and sixth grade students are exposed to language arts in a technology-rich multimedia environment. Installed only last year and funded though a West Virginia Department of Education Technology Demonstration Sites Grant, the glass-enclosed room contains a Macintosh computer; large-screen television/monitor; overhead projector; LCD pad which can be used to project the computer image to the entire class; CD-ROM drive; laser disc player; laser printer; scanner; and a Zap Shotcamera which allows pictures taken to be shown on the television/monitor. Various software, laser discs, and compact discs (CDs) are used every day for instructional purposes.

The director of the site, who is the language arts teacher, has a total of 168 students daily in scheduled 40-minute periods. In an interesting use of technology, the students are videotaped while doing oral presentations of their written projects. Software used for written expression includes word processing and desktop publishing programs. Primarily used for enhancement activities, the site, according to the director, meets the needs of many of her students because of the interactions, motion, and lack of intimidation of the technology. During one classroom observation, a laser disc tutorial of French vocabulary was being used and held the attention of all students as they repeated aloud what they saw on the screen.

Students in Kindergarten through Grade 4 are also exposed to multimedia when scheduling of the site permits. The director is instructing teachers in general use of the equipment and reports that they are beginning to feel capable of controlling it. She also tries to integrate in her teaching any relevant software that the students may be studying in other subjects. For example, laser discs dealing with the United States Presidents and First Ladies are used in a cross-curricular fashion with both social studies and language emphasis.

Before the installation of this multimedia site, language arts for fifth and sixth graders was taught in the Clusters with traditional paper-and-pencil activities. Future plans for including the present computer on a network are under discussion, and the purchase of software for other content areas will be considered as the site continues to develop.

Science Lab. In prior years, science teachers at East Dale Elementary were confined to teaching in their own classrooms and areas; but, with the inception of the Science Lab last year, their students are now exposed to a variety of technological equipment that piques the interest of students and teachers alike. A series of math and science software is used along with word processing, but the six Apple IIgs computers were purchased specifically for use with the *LEGO* Robotics program which students use to control features and actions of various projects such as carousels, optical scanners, cars, and machines. A climatarium affords experiments with different wave lengths of light, temperature, humidity, and acid rain while learning about plant growth. Other science equipment used in the lab include microscopes, fresh-water marine aquarium, and embossed desk-tops on which measurement devices, graphs, and data recorders are located.

The lab is used primarily for fifth and sixth grade; but, as early as Kindergarten, students are exposed to the *LEGO* construction principles of levers, simple machines, and physical laws. The director of the Science Lab has worked collaboratively with other teachers in developing the curriculum and corresponding activities for lab use. He has spent time training them to use the technology and is still in the process of doing so. The curriculum stresses technology for communication, manufacturing, construction, and business.

Students from surrounding schools sojourn to the Science Lab in scheduled visits. Fourteen schools send students in Grades 3 through 6 for a monthly exposure of three hours. Early next year, the director will be supervising after school and Saturday programs in the lab for nearby communities.

A Macintosh LC computer has been purchased with plans for using it as a file server to network with other computers in the building. Due to the recent origins of the lab, the director is working on teacher training to aid in implementing the present technology rather than acquiring more hardware or software. He feels that ". . .all too often technology and new things in the classroom get put aside for lack of an understanding by the teachers." With that in mind, he is trying to "settle in and make use of what we have."

Other Areas. Technology appears in many areas of the school and it is not unusual to find a computer sitting by a table in an out of the way place such in the remedial reading teacher's space located adjacent to the Library. The Library has two IBM computers for management of resources and student use of Collier's Student Encyclopedia. There are two large screen monitors for whole class viewing of videos and the school's gifted students have exposure to computers in their program.

Summary of Results

Past Implementation. Generally speaking, past uses of technology included items such as posters, bulletin boards, silent or sound filmstrips, video tapes, overhead transparencies, 35 millimeter slides, and limited use of instructional television broadcasts. Single computers are now available in each cluster for teacher use along with networked and stand-alone computers for student use where, in past years, none existed (See Figure 1).

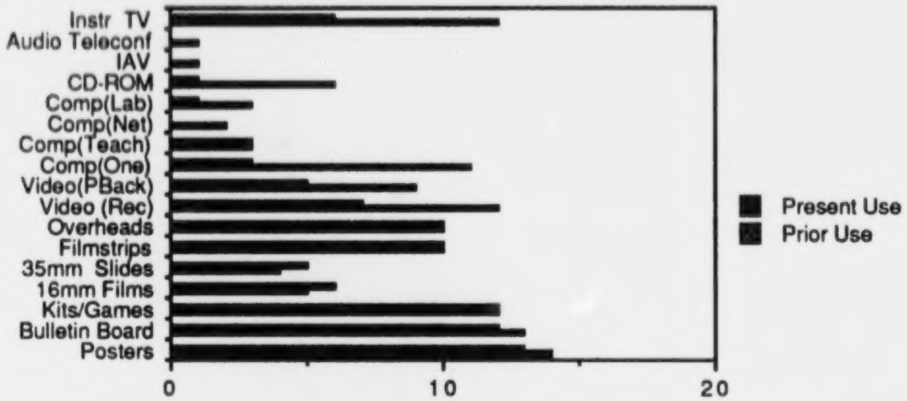

Figure 1
Present and Prior Technology Use - East Dale

Present Implementation. Students at East Dale Elementary School are exposed to technology from Kindergarten through sixth grade. General classwork in the Clusters is enhanced with stand-alone computers and those on networks, while special areas such as the Technology Demonstration Site for language arts, the Science Lab, and the Computer Lab are available for instruction in those specialized areas. The technology is up-to-date and being used regularly. Teachers have taken the initiative in learning how to teach with technology and are sharing their knowledge with other schools and students.

Many teachers have become comfortable with using various technologies in their teaching such as CD-ROM (compact disc-read only memory) disks, instructional television broadcasts, and videotapes. Some have reported the use of overhead transparencies and 16 millimeter films as new uses since restructuring efforts have begun, while one teacher reported the use of a two-way audio teleconference in her pedagogy.

Today, technology at East Dale is used to the greatest degree for classroom instruction, but some teachers have reported using it for managerial purposes and professional development as well (See Figure 2). The computer is used, at times, as a secondary instructional tool (reinforcer for primary instruction) and as a reward, but most teachers reported using games and drill-and-practice-type software (See Figure 3) for supplementary instructional activities in their educational scheme (See Figure 4).

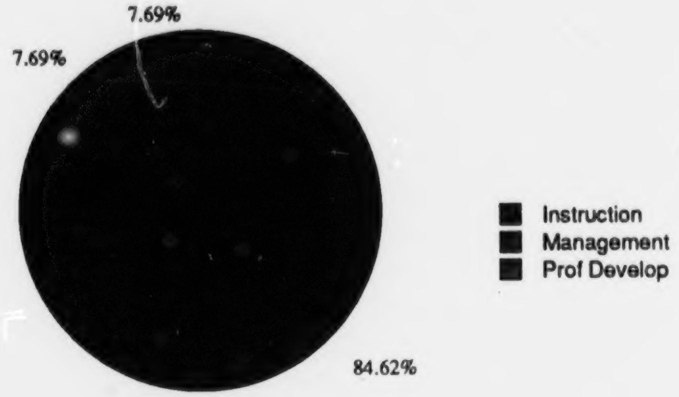

Figure 2
Overall Use of Technology

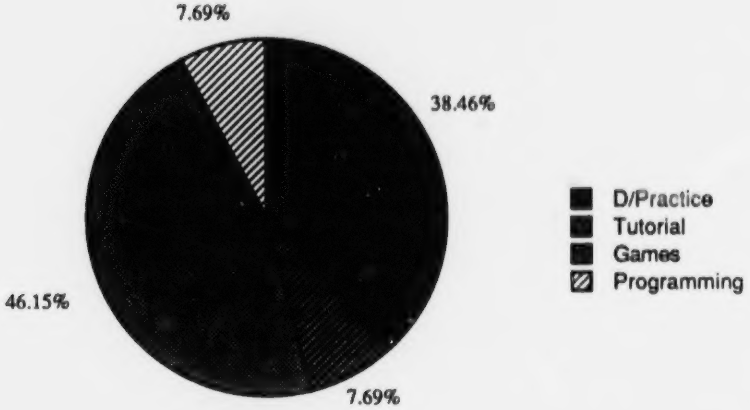

Figure 3
Type of Software Used

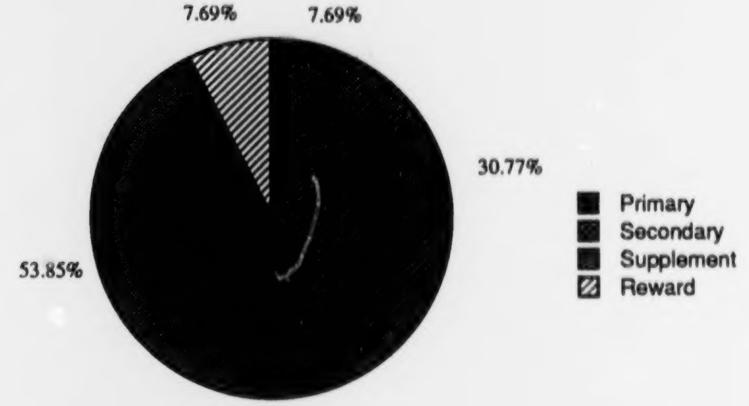

Figure 4
Instructional Use of Technology

Future Implementation. East Dale's faculty is not content with what they have, but are planning future improvements for their instructional technology. Networking with other areas of the school, modems for communications between schools, more hardware, and additional software are on the agenda. Plans are directed through the Technology Committee whose membership is voluntary and represents various categories of faculty and administration.

A troublesome concern of the presence of abundant technology was voiced by more than one faculty member. There is a fear that when sixth grade students leave East Dale, and enter a school with less to offer in technology-related instruction, they will not be as motivated to learn as they are now. The Science Lab director quoted a substitute teacher as saying that when she is at other schools teaching she often finds herself thinking "... if I only had East Dale's equipment, I could shown them this [material] so much more clearly." While this is a valid concern, it is not one that should deter any use of technology, rather it is hoped that the secondary schools will see the value of technology and implement it in their various curricula.

Study 2: Morgantown High School
Design of the Study

Sample

Approximately 1,381 students in Grades 10 through 12 attend Morgantown High School in Morgantown, West Virginia, located near the campus of West Virginia University. There are 80 faculty members, a principal, and an assistant principal in this large secondary school that has an average class size of 21.5.

Method

Morgantown High School was recommended by the Assistant to the Director of the Benedum Project at West Virginia University as a school with a high use of technology. Data from teacher and administrator questionnaires (same as Study 1) were collected during the same time frame as Study 1 (October, November). Four teacher interviews were conducted and videotapes of classroom use of technology were taken.

Procedures

Teacher questionnaires were distributed to the faculty of Morgantown High by the principal at a faculty meeting with a request to complete them in two weeks. Fifty-two teacher and one administrator questionnaires relating to the present, past, and future uses of technology were returned from a pool of 81 for a return rate of

64%. The quantifiable data collected were entered into a database for comparison purposes.

Three teachers were interviewed and audio-taped, while one phone interview was conducted with a fourth teacher. The interviews were semi-structured and the teachers were chosen upon recommendation of the principal and as a result of a request for volunteers on the teacher's questionnaire. Classroom observations were accompanied by taking still pictures and videotape of the students while using various forms of technology. Journal notes were taken during the observations.

Analysis

To answer the research question of what technology is being used in this restructuring school and how it is being implemented, the transcriptions of teacher interviews were read several times; the results of database information gathered from teacher questionnaires were categorized and represented graphically; and the journal notes from classroom observations were studied.

To answer the research question of how technology was implemented prior to restructuring, data from teacher questionnaires were extracted and transformed into graphical representations; transcriptions of teacher interviews were reviewed and information relating to the use of technology was extracted.

To answer the research question of what future plans are for technology acquisition and implementation, teacher questionnaires and transcriptions of teacher interviews were scrutinized.

Results

Descriptive Overview

Simply stated, the vision of the restructuring movement at Morgantown High is: "Morgantown High School: A School for the 21st Century." The belief is that, with the rapid changes that are taking place in the world, students must be prepared in the "new basics" of problem solving, decision making, critical analysis, reasoning and thinking skills, computer usage, and communications in addition to the basic knowledge required for usage of those skills.

Technology at Morgantown High is viewed generally as a means to an end, not an end in itself. There are individual teachers that use up-to-date technology in their classrooms, but three computer labs form the basis of technology implementation at the school. The long-range goal is to completely computerize the entire school and to network all classrooms together with six computer stations in each classroom for student use and one for teacher use. A Technology Committee, comprised of faculty members and administration, meets regularly to coordinate the use of and discuss the need for additional technology at the school.

Most of the technological use at Morgantown High is centered in the three computer labs which are categorized by departmental use. These include the: (1) Writing Lab, (2) Business Lab, and (3) Math/Computer Science Lab. The computers in these three facilities are networked together so that all users can access any software from any lab. Other areas of use include the journalism department, Social Studies classroom, Library, and the availability of computers on carts for any classroom.

Writing Lab. Prior to the inception of the Writing Lab, one English teacher had an Apple II computer purchased with a grant for use in remedial instruction. After becoming familiar with the benefits of technology, she transported students to West Virginia University's Human Resources and Education Computer Lab for instruction after school. She was gratified to notice that even students who did not like "regular" school would be present for this type of tutelage. Soon after seeing the advantageous effects of computer use, the Board of Education funded the present English Writing Lab. In place for five years, the lab is designated for all English teachers' use, although health and guidance teachers also schedule time for their classes. Various health and guidance software is placed on the network server for use by those classes.

When the lab was originally opened, one of the English teachers reported that some of the math and science teachers voiced doubt that another department could make use of a computer lab. Staff development time was used to train the teachers in the use of computers in writing instruction with the result that now most classes use the lab profusely and as one teacher said "... our students are profiting greatly [from using the computer]." Word processing software along with composing process software such as *Writer's Helper* and *SEEN* are used to help students learn the techniques of writing as a process and how to write critical analyses. The 25 IBM computers and two printers are starting to show their age from heavy use, and the teachers who use the lab would like to see new hardware, such as color monitors and dual disk drive-computers, purchased in the future.

Business Lab. Word processing, integrated programs, and typing tutors are examples of the software used in the Business Lab which contains 25 IBM networked computers and two printers. Business students are the primary users of the lab and have help available from lab assistants chosen by the teacher. The students have been quoted by one of their teachers as saying that they "... learn more by being an assistant than by being just a student."

Multimedia technology is also offered in this lab using *LinkWay* software. The program allows users to create folders of their own information. It is an elective class in which students complete tutorials on the use of the software and projects such as autobiographies; at the end of the semester, they will contract with a teacher from another subject for future assignments in that class to be done with multimedia. In a related use of multimedia, a laser disc player is connected to a monitor and is being tested for a publishing company with provided software.

One of the teachers stays after school one day a week and one lunch hour to permit students to use the facilities beyond their normal class time. This is typical of the attitude of the teachers found at Morgantown High. They are quite willing to cooperate and share their knowledge of technology with others, even on their own time. Often at school from 7:00 A. M. until 5:00 or 6:00 P. M., some faculty members use after-school hours to learn how to use and implement the latest developments in teaching with technology.

Math/Computer Science Lab. Subjects such as Computer Concepts, Computer Science, Transitional Math, Integrated Computer Applications, Pre-Calculus, and Trigonometry are all taught in the Math/Computer Science Lab, which is directed by the Technology Coordinator at Morgantown High School. She is responsible for scheduling time for classes in all labs. For one half of her day, the director teaches Computer Science classes and the other half performs duties as lab coordinator which, beside scheduling lab time, include: repairing equipment; advising and training teachers in the use of hardware and software; purchasing software; and planning for innovative uses of technology in the school. The labs are heavily used by certain subject areas which results in other departments being able to schedule the lab only for occasional use (See Appendix C for a sample weekly schedule).

In this lab, 25 IBM computers and two printers are engaged every day using instructional software for the appropriate subject areas. Math teachers use remedial programs, fraction tutorials, pre-calculus, and trigonometry software to enhance their teaching. Computer science classes learn ADA programming. Classroom management software and desktop publishing software are the newest additions on the network and there are plans to train teachers in their use.

Other Areas. The journalism department has a temporary location this year while remodeling is taking place in their future lab area which will house a planned 25 to 30 Macintosh computers. Presently the school newspaper, yearbook, and a county newsletter to parents is produced on four Macintosh computers and a laser printer, using word processing and desktop publishing programs. Many times the department is asked to produce brochures and programs for various functions or groups involved with the school. Advanced journalism students are involved in production of all the publications. Computer technology has been in use for about five years now and the journalism teacher would like to see a multimedia lab, television production, and integration of classes for the development and viewing of various in-house productions incorporated for future use. He can also see uses for having the new lab networked, a scanner, and an LCD pad for projections on a large screen in his teaching. The biggest stumbling block for these future goals is financial. Some plans may have to be deleted from the new lab because of lack of adequate funding.

Morgantown High School was selected as one of 28 schools in the United States to test the IBM Ultimedia products, *Columbus* and *Illuminated Books and Manuscripts*. Placed in a Social Studies classroom, the students use the station in groups, individually, or for whole-class viewing. Research on student-chosen or teacher-assigned topics is completed in a cross-curricular fashion; that is, the student can use the resources for assignments in any class. The Social Studies teacher has only recently become familiar with using technology in his classroom through attendance at a workshop and has become an advocate of its use. Future plans call for a large screen monitor to aid in entire-class viewing.

In addition to labs, teachers have access to Apple computers which are placed on carts and may be transported to individual classrooms. The Library has IBM computers and a TANDY machine with an encyclopedia installed for student use.

Summary of Results

Past Implementation. The most common, former uses of technology included posters, bulletin boards, filmstrips, and overhead transparencies with some lesser use of instructional television and computers. Since additional technology has become available in recent years, there has been an increase in the use of videotapes, stand-alone computers, teacher-station computers, and networked (lab) computers. CD-ROM technology and interactive videodiscs are also reported new uses of technology, albeit not to a great extent (see Figure 5).

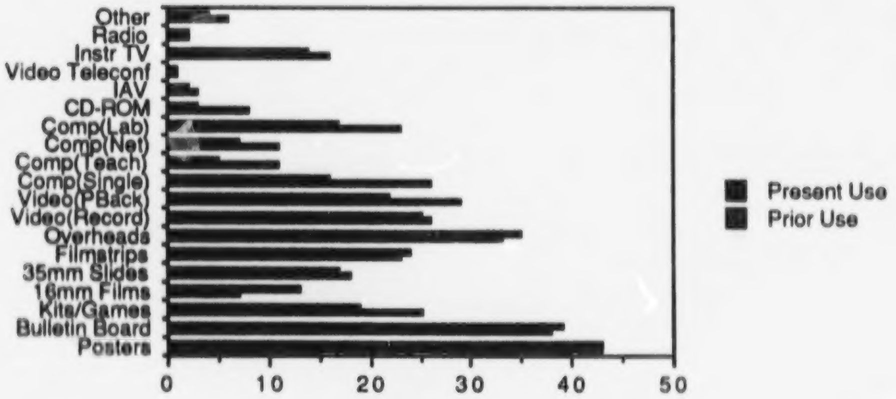

Figure 5

Present and Prior Technology Use - MHS

Present Implementation. Three computer labs form the basis for most computer activity at Morgantown High School including the: (1) Writing Lab, (2) Business Lab, and (3) Math/Computer Science Lab. Due to the heavy use of these labs, there is not much available time for other subject areas to become greatly involved in technology use. Individual subject areas such as health and guidance are scheduled for use in the labs, but only on a limited basis. A core of teachers is learning to use ultimedia software and some are implementing it in their teaching. The journalism department creates a variety of publications which are all done on the computer. The Library has computers available for student use and transportable computers placed on carts can be used in classrooms.

Most teachers use technology in classroom instruction, but a strong second use is found in classroom management for record-keeping and a few are using it for professional development activities (see Figure 6). Survey results showed that in using technology for instructional use, it is being used mainly as a supplement to regular instruction, but many are using it as a primary and secondary method of teaching. One teacher reported the use of technology as a reward (see Figure 7). Drill and practice software is the leading type of software being used in the classroom, but tutorials have strong use, while games and programming languages also have places in the curricula (see Figure 8).

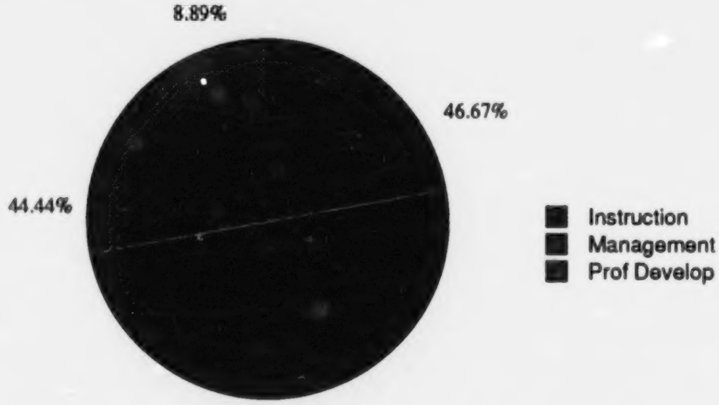

Figure 6
Overall Use of Technology

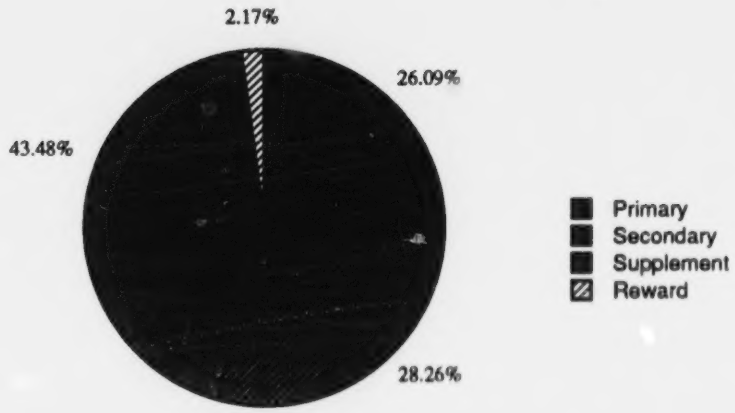

Figure 7
Instructional Use of Technology

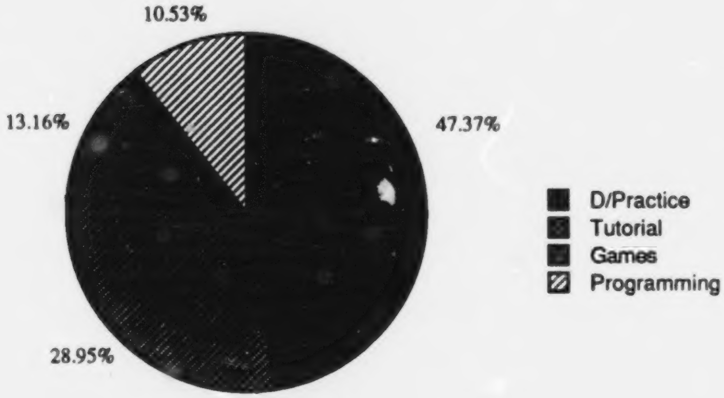

Figure 8
Type of Software Used

Future Implementation. The Technology Coordinator feels that the school is ready for computers to be placed in individual classrooms. Heavy use of the existing labs and disruption of the normal flow of classroom instruction through trips to the lab are problems that could be rectified by having technology available in the teacher's room. In response to an in-house survey of the faculty, a great majority were found to be in favor of expanding technology from the labs to their classrooms. Channel One television will soon be present in each room and teachers are looking forward to their future classroom which will contain one teacher and six student computer stations.

Recently, Morgantown High was awarded the status of a West Virginia School of Excellence. They have made inventive use of an older building in devising space for technology to be incorporated into the educational process. Many teachers and administrators are convinced of the worth of using a variety of tools to aid in the classroom and have implemented them in unique cross-curricular approaches.

Conclusions

In an almost unanimous voice, the teachers at East Dale Elementary and Morgantown High School agreed that technology is a necessary ingredient in restructuring schools. Many of them declared that, because of the abundance of technology in the "real world," the school should provide students with the knowledge of and the ability to handle what they will find in their everyday lives. On the other hand, with the same strength of voice, they stated that technology is only a tool in their arsenal and should be used as such in their teaching methodology.

Time for training and money for funding were problems raised by the faculty at both schools. The typical teacher's day is already full of demands, and finding the time to learn how to effectively use technology is a stumbling block for many of them. Often teachers use their own time to become acquainted with new tools. When the obstacle of training is overcome, the problem of financing modern technology is another issue to be addressed. A little use of technology seems to create the desire for more and improved technology. Money is a problem in all of society today, but especially in schools where tax dollars must be spent judiciously.

Both schools have managed to find ways to alleviate, to some extent, the problems of time and money in implementing technology in their schools. Aggressive and inventive applications for grant funding, along with County and State contributions, are common ways of purchasing equipment. Teachers have voluntarily given of their own time on occasion to learn new technology; while, in other instances, release time has been funded for training. Because of their strong feelings for the place of technology in education, faculty and administration have worked together to find solutions for these problems.

Restructuring efforts have created an atmosphere of cooperative and collaborative educational innovations. Cross-departmental pooling of resources, risk-taking, and new attitudes of ownership for the educational process have all contributed in allowing instructional activities to take new form and shape. Technology has played a vital part in many of these activities and in making both East Dale and Morgantown High worthy of being exemplars in educational circles.

The extremely cooperative faculties and administrators at both schools have afforded an enormous amount of information from this study. Future research implications include examining what ingredients are necessary for teachers to use technology in their classroom; advantages and disadvantages of technology in the classroom; if restructuring has caused an increase in the use of technology; and funding for technology.

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Title:

Error and Feedback: The Relationship Between Content Analysis and Confidence of Response

Authors:

John V. Dempsey
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Abstract

Our prior studies using science-related concepts and rules have indicated that learners spend twice as much time studying feedback after fine discrimination errors than they do after gross errors. Likewise, studies by Kulhavy and his associates suggest that learners expend longer feedback study times after errors for which they had a high confidence of response. The purpose of the present study was to see if there were a relationship between discrimination error (determined by content analysis and tryout data) and confidence of response (determined by self-report). Results indicated that, as in prior studies, the relationship between fine discrimination error and feedback study time was positive. The relationship between fine discrimination error and confidence of response, however, was negative. Possible explanations for these results are discussed.

Error and Feedback: The Relationship Between Content Analysis and Confidence of Response

In his classic review, Feedback and Written Instruction, Kulhavy (1977) proposes a model of learner expectancy. Kulhavy's model expresses the relationship between correct or wrong answer post-response feedback given to a learner and her self-reported confidence of response in making that reply in the first place. High confidence error feedback (wrong answer feedback for erroneous responses the learner had expected to be correct) are predicted to yield longer feedback study times than either low confidence error feedback or feedback after correct responses.

Kulhavy's model adheres to the first of Ammons' eight empirical generalizations which states, "The learner usually has a hypothesis about what he is to do and how he is to do it, and these interact with knowledge of performance" (1956, p. 281). Based on pilot data, Kulhavy, Yekovich, and Dyer theorized that learners create a hierarchy of confidence in the the correctness of their responses. Under these conditions, learners' reactions to error range from surprize when confidence is high to acceptance when confidence is low (1976, p. 522). These observations were validated by several experimental studies (Kulhavy et al, 1976, 1979; Kulhavy, White, Topp, Chan, & Adams, 1985; Lhyle & Kulhavy, 1987) and further, endorse the "common sense criteria" so often ignored in experimental research involving human learning.

From a differing perspective, we felt that an area of concern in the work of Kulhavy and his associates was the reliance on learner's self-reports of the confidence of their responses. In the studies conducted by Kulhavy and his associates and the present study, which emulated their procedure, learners stopped after each response and rated their confidence in each response. Although the notion of a learner-constructed response hierarchy made intuitive sense to us, we wondered how often learners accurately portray the response hierarchy with which the question was actually answered. Clearly, we felt, more sophisticated learners with greater strategic learning ability would have an advantage over those with less ability. Likewise, older learners would have advantages in understanding their response hierarchies over very young learners (Kulhavy, Stock, Hancock, Swindell, & Hammrich, 1990).

Additionally, during instruction, self-report measures are distracting. In essence, learners are asked two questions, one content-related and one not. Unless, as is possible, the self-report measures were used as part of a game format (see, for example, Scarth & Litchfield), their use in instructional situations would be impractical.

Work involving the use of rational sets of concepts and simple rules (Driscoll & Tessmer, 1985; Klausmeier & Feldman, 1975; Markle & Tieman, 1970) have established a method by which errors of fine and gross discrimination, two ends of the error continuum, may be predicted. This method was adapted to the computer (Dempsey, 1986; Driscoll and Dempsey, 1987) and refined (Dempsey, Driscoll, & Litchfield, in press) by comparing the predictions of fine and gross discrimination errors (i.e., content analysis) with actual on-task observation of errors made during instruction. Our prior experiments using rational sets of concepts have indicated that learners make a higher number of incorrect answers that are fine discrimination errors than gross discrimination errors. Consistent with this research, we expected learners to make more fine discrimination errors than gross errors in the present study.

An important indicator of how engaged learners are in the instruction is the amount of time they spend studying textual feedback given after incorrect responses. Kulhavy and his associates (Kulhavy, Yehovich, & Dyer, 1976, 1979; Kulhavy, White, Topp, Chan, & Adams, 1985) have asserted also that students' expectancy for success is related to the amount of time students spend studying feedback. Likewise, based on prior studies with science concepts (e.g., Litchfield, Driscoll, & Dempsey, 1990), we expected that students would spend more time studying fine discrimination errors (errors associated with concepts which had similar attributes to a correctly classified concept). A student making a fine discrimination error, we posited, would have a high expectancy for success. Fine discrimination errors were, after all, close-in nonexamples of correct concepts. Making incorrect responses that were "almost" correct should serve to increase attention and stimulate curiosity. Under these conditions, feedback study time would be extended.

Gross discrimination errors, on the other hand, were far-out nonexamples and suggest that learners have failed to comprehend the material. We expected that learners will spend less time studying corrective feedback for gross discrimination errors. Failing to understand a concept or rule, learners guess quickly and move on to areas they better understand. It may be supposed that a learner who makes a gross discrimination error has little expectancy for success in classifying that particular concept.

Naturally, because our work and that of Kulhavy and associates made predictions based on assumptions of learners' expectancy for success, we speculated that these approaches were linked in some way. The purpose of the present study, therefore, was to see if there were a relationship between discrimination error (determined by content analysis and tryout data) and confidence of response (determined by self-report).

Method

Subjects and Procedure.

The subjects in this study were 63 mostly freshman and sophomore university students enrolled in a biology class for nonmajors. The class, which fulfilled a basic studies requirement for undergraduates, had a traditionally high enrollment and unsatisfactory pass/fail ratio. Subjects comprised three laboratory classes chosen by the undergraduate Biology coordinator to participate in a pilot program which incorporated the use of adjunct computer-based instruction (CBI).

Prior to completing the computer-based instructional module, students read a 12-page chapter on the topic of substance abuse from a required text produced by the Biology Department. Two hours of classroom time were also devoted to expository information of the module topic. Students received credit for completing the CBI module at their convenience during a 10-day period. To complete the CBI module, students located an unoccupied computer terminal at one of several public access locations on campus and "sign-on" to the system. After typing in their names and social security numbers, subjects were given all additional instructions by the computer program.

Materials and Instruments.

The content of the instruction were selected rational sets of concepts and rules related to a newly-introduced, state-mandated substance abuse module. The rational sets of interest in this study were types of drugs (defined concepts), the effects of drugs on the nervous system (rules), and alcohol use and abuse (rules) and included 44 exemplars. An instructional design strategy, the rational set generator, was applied in the design and development of the instruction. The rational set generator is a matrix model that incorporates multiple examples of concepts and rules and provides for discrimination and generalization learning. Discrimination here refers to the ability to make distinctions between examples and nonexamples of concepts and rules. The interrogatory examples used in this study required that subjects classify particular concepts or rules after reading narrative anecdotes containing varying degrees of concept or rule attributes. The CBI rational set generator used an adaptive strategy which branched subjects to more difficult examples after correct classification and easier examples after incorrectly classifying or applying concepts or rules. Items answered correctly were discarded from the program.

Fine and gross discrimination errors were diagnosed using a two-step approach. First, content experts predicted the relative likelihood of making a discrimination error for each nonexample distractor by considering the content relationships among concepts or rules in a rational set. Distractors representing closely related nonexamples, for example, were more difficult to discriminate than less closely related nonexamples and would represent fine discrimination errors. Thus, nonexamples were rank ordered by their "rational" content relationships. Second, before analysis this predictive relationship was compared to actual student responses and, where necessary, items were adjusted to reflect discrimination error trends.

Before subjects received any feedback, they were queried about their confidence of response in a similar manner to that proposed by Kulhavy et al (1979). A five point scale (1= lowest confidence, 5=highest confident) composed of touch boxes, and a question asking the student how sure she was about her answer appeared at the bottom of the computer screen immediately after a content response was made. After indicating confidence of response, subjects received content response-contingent feedback. Simple confirmation was provided for correct answers. After incorrect responses, subjects were informed of the correct concept or rule in a standard feedback box which remained on the screen along with the interrogatory example until students chose to touch the screen or press the keyboard to continue on to the next example.

In the present study feedback study time was collected after incorrect responses only. Feedback study time was defined as the elapsed time from the moment when response-contingent feedback was first presented on the computer display screen until the learner pressed the appropriate key to view the next item.

Results

The results of the study indicated that, as may be expected, students spent more feedback study time and required more question-based examples in studying content involving rules than concepts. Otherwise, as Table 1 indicates, the patterns were quite similar across the three learning outcomes used in this study, i.e., drugs, coordinate (or rationally-related) defined concepts; drugs, coordinate rules; and alcohol, successive (or nonrelated) rules.

Insert Table 1 about here

Feedback study time was directly correlated with fine discrimination errors (r = .456) as shown in Table 2. As expected, students spent much more time studying feedback after fine discrimination errors than gross errors.

Suprisingly, confidence of response was inversely correlated with feedback study time (r = -.469) as well as fine discrimination error (r = -.466) and gross error (r = -.479).

Insert Table 2 about here

Discussion

Although these findings are far from conclusive, two possible explanations could explain the negative relationship between fine discrimination errors and confidence of response. These are: (1) inconsistencies with the learners' self reports of their confidence of response, and (2) the relationship between high confidence errors and effort.

In the Kulhavy studies (as well as the present study) learners stopped after each response and rated their confidence of response. One wonders how often learners accurately portray the response hierarchy with which the question was answered. We would suppose, for example, that there would be a great difference in the reliability of self-reported confidence measures among sophisticated learners versus those with less ability -- or older versus younger learners.

An initial investigation by Swindell, Greenway, and Peterson (1992) upholds our suppositions. In a study with 4th and 6th grade students, these researchers found that 6th graders were more reliable in estimating response confidence than were 4th graders. They also found that the response patterns of the 6th graders were similar to those of college students (Kulhavy, Stock, Hancock, Swindell, & Hammrich, 1990), but response patterns of the 4th grade students were distinctly different.

Other researchers have called into question the use of self-reported confidence measures. For example, Koriat, Lichtenstein, & Fischoff (1980) have found that people are often overconfident in evaluating the correctness of their knowledge. Their research supports the notion that learner's assessment of confidence is biased by attempts to justify one's chosen answer. In discussing self- reports, Borg and Gall (1983) observed, "people often bias the information they offer about themselves, and sometimes they cannot accurately recall events and aspects of their behavior in which the researcher is interested" (p. 465).

In addition, self report measures during instruction are distracting. Essentially, learners are asked two questions, one content related and one not. Thus, the practical value of self-report as an instructional or motivational design measurement tool is reduced.

Regarding our second speculation, the findings of this study, considered in respect to the existing text-based feedback literature, indicate a more complex relationship between the type of error made (determined via content analysis), expectancy (measured by confidence of response scales), and the amount of effort a learner makes (as measured by feedback study time) than had been suspected. This relationship is illustrated in Figure 1. In addition to other factors, we suspect that confidence of response measures are greatly influenced by specific learning outcomes, the difficulty of material to be learned, the learner's prior knowledge, and the relevance of the material to the learner.

Insert Figure 1 about here

One practical implication of the present study is for researchers to explore more sophisticated systematic explanations for the use of corrective feedback in interactive instruction. While the tendency is to look for simpler clarifications such as those proposed by Kulhavy (1977), the evidence of this and certain other studies suggest the relationship among error, expectancy, and feedback is a complex one. More recent work among several researchers (Dempsey, Driscoll, & Swindell, in press; Kulhavy & Stock, 1989; and Bangert-Drowns, Kulik, Kulik, & Morgan, 1991) have begun to address these concerns at least within the limited area of text-based feedback. What is needed are disciplined explorations of these and other models.

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Table 1

Descriptive Statistics for number correct, attempts, feedback study time, fine & gross discrimination errors and overall confidence of response (n = 63).

VARIABLE*	MEAN	SD
B-correct	7.08	.83
C- correct	6.20	.99
D- correct	12.02	2.21
B-attempts	11.79	4.95
C-attempts	15.05	3.95
D-attempts	20.12	2.59
B-FB study time	131.46	211.72
C-FB study time	176.30	209.19
D-FB study time	170.73	178.37
B-fine errors	.73	.61
C-fine errors	2.11	1.47
D-fine errors	1.89	1.23
B-gross errors	.56	.98
C-gross errors	.76	1.10
D-gross errors	.65	1.01
Confidence of Response (all 3 matrices)	3.807	.396

Note: 44 items -- from three instructional matrices:
B matrix = drugs (16 items, defined concepts)
C matrix = drug rules (12 items, simple rules)
D matrix = alcohol (16 items, simple rules)

Table 2

Intercorrelations among the variables of feedback study time, confidence of response, fine discrimination errors, and gross discrimination errors ($n = 63$).

Variable	FB Study Time	Conf of Response	Fine Errors	Gross Errors
FB Study Time	1.00			
Conf of Response	-.469*	1.00		
Fine Errors	.456*	-.466*	1.00	
Gross Errors	.204	-.479*	.055	1.00

* $p < 0.001$

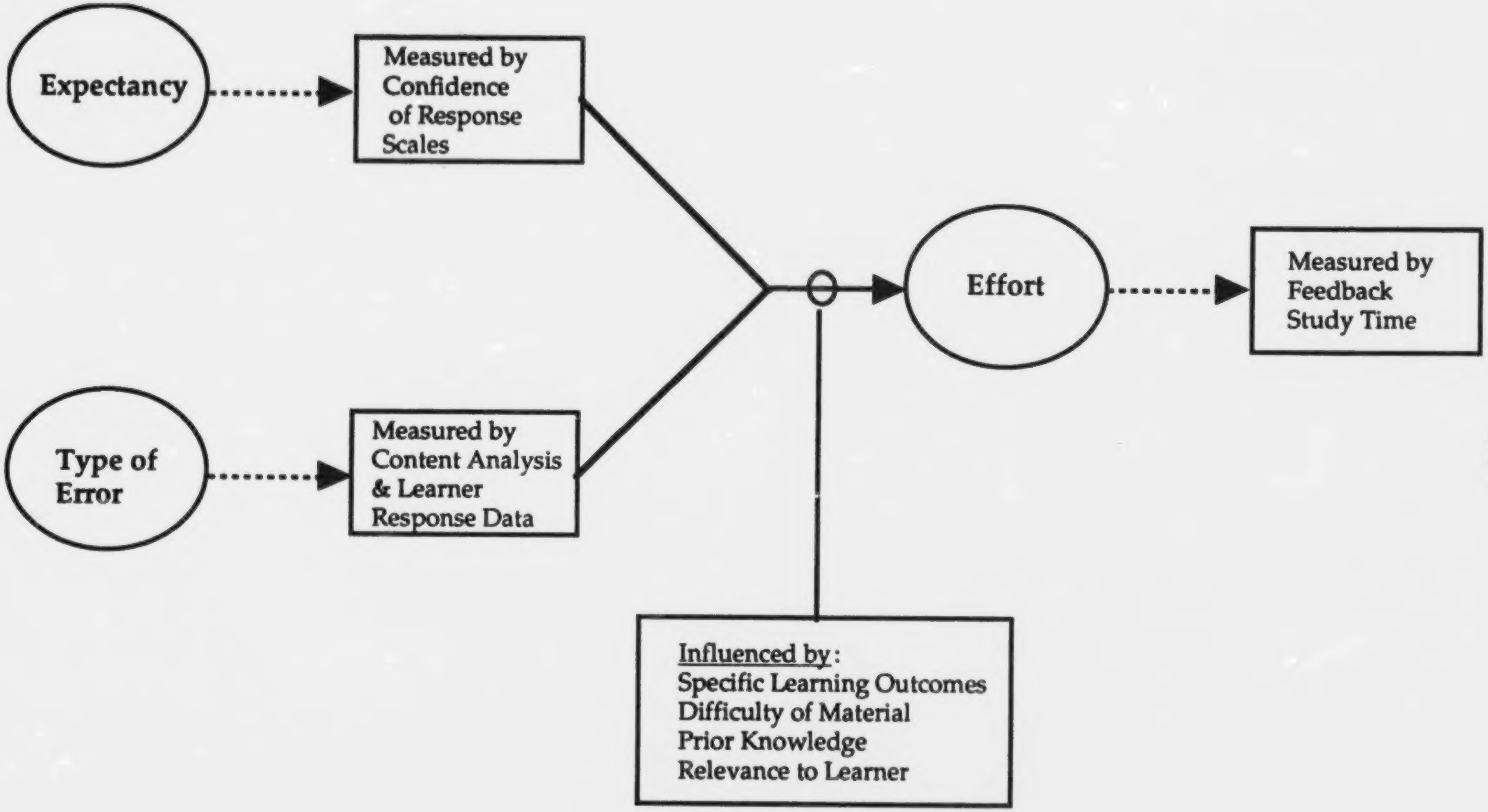
Expectancy
Measured by Confidence of Response Scales
Type of Error
Measured by Content Analysis & Learner Response Data
Effort
Measured by Feedback Study Time
Influenced by:
Specific Learning Outcomes
Difficulty of Material
Prior Knowledge
Relevance to Learner

Figure 1. Possible relationship among expectancy, type of error, and effort.

Note. From J. Dempsey, M. Driscoll, & L. Swindell (in press) Text-Based Feedback. In J. V. Dempsey & G.C. Sales (Eds.). Interactive Instruction and Feedback. Englewood Cliffs, NJ: Educational Technology Publications.

Title:

Student Performance and Attitudes Using Peer Collaboration in Accounting

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STUDENT PERFORMANCE AND ATTITUDES USING PEER COLLABORATION IN ACCOUNTING

ABSTRACT

Purpose

The present study was conducted to investigate the effects of peer collaboration and individual study as modes of practice, using the lesson content of a required introductory accounting course. The study also examined the effects of using content organizers on the practice worksheets.

Method

Data were analyzed using a 2 x 2 analysis of variance comparing posttest performance across practice modes (peer collaboration and individual) and content organizer treatments (organizers versus no organizers). Data from the attitude questionnaire were analyzed for variations in responses between the peer collaboration and individual-work groups.

Results

Students showed a significantly higher level of achievement using the practice mode of peer collaboration, as well as having significantly more positive attitudes towards this method of classroom practice in problem solving.
Several factors may have contributed to the positive results for peer collaboration. These include providing and explaining the answer, obtaining feedback and discussion, and playing an active role in learning.

The study of accounting lends itself well to group review as part of the learning process. Even the accounting profession depends on peer review and peer consulting to strengthen the validity and accuracy of individual work. In recent years, the profession has been vocal in its concern that higher education, while providing technically educated graduates, must also help develop the intellectual, interpersonal and communication skills of accounting majors. Patten and Williams (1990) summarized the key issues that require a "thorough re-examination of the total accounting experience," citing increased communication and interpersonal skills as two key issues.

Cooperative learning among students is becoming increasingly popular in educational settings. Slavin (1987) defines cooperative learning as having four components of 1)group task, 2)incentive, 3)motive and 4)behavior. Group work is deemed to be cooperative if the students work on a common assignment (group task); have an interdependent reason to work together (incentive); want to work together (motive); and work as a team (behavior) (Hooper, in press).

Cooperative learning methods are usually based on one of two major theories, developmental and motivational. Developmental theory holds that the interaction of the group _itself_ leads to improved achievement, whereas motivational theory says achievement depends on the goal/reward structure (Slavin, 1987). The reward structure in developmental theory appears more intrinsic whereas the reward structure in motivational theory is more extrinsic. Most empirical findings support the reward structure of motivational theory, but Slavin suggests combining and reconciling both theories to provide the strongest results.

The area of applied accounting content, such as found in introductory accounting classes, may provide a particularly good environment and educational setting for using peer collaboration. Students often have difficulty in accounting and are frequently uncertain about their answers to applied problems. Peer collaboration could provide a second opinion of their work, similar to what practioners use. It could also give the students an opportunity to discuss and elaborate on both the accounting content and the problem methodology.

Peer collaboration, as a type of cooperative learning, may provide a link between these two types of reward structures. The ability to explain or defend an answer to a peer may increase comprehension and correct misconceptions. These results could lead to improved learning and could also provide both intrinsic and extrinsic rewards for the students.

The ability to organize new information and extract the key steps or rules may improve performance (Ellis, et al, 1986). Tessmer, et al (1990) proposed an approach to teaching and learning concepts that would include demonstrating to the students a way to arrange or think about new materials. Accounting education has also attempted to help students organize the concepts into important ideas or "rules", to facilitate both recall and application of the materials. Often, these content organizers are verbally expounded by the instructor, but they may or may not be used by the student in solving the accounting problems.

The present study was conducted to investigate the effects of peer collaboration and individual study as modes of practice, using the lesson content of a required introductory accounting course. The study also examined the effects of using content organizers on the practice worksheets.

The three primary research questions were:

1. Which is the more effective method of practice.individual practice or peer collaboration, in solving accounting problems?
2. Does the use of content organizers with practice worksheets increase learning?
3. What are the effects of peer collaboration and individual practice methods on student attitudes?

METHOD

Subjects

The subjects in the study were 211 college students (sophomores, juniors, and seniors) enrolled in the first semester of Introductory Accounting at a large southwestern university. The Introductory Accounting classes are prerequisites for entry into many of the professional programs in the College of Business (Accounting, Marketing, Management, Computer Information Systems, and General Business).

Procedures

The study was conducted using a 2 (individual/peer collaboration) X 2 (organizers/no organizers) design. This resulted in four separate treatment groups: Peer collaboration with content organizers, peer collaboration without content organizers, individual practice with content organizers, and individual practice without content organizers. Students attended their scheduled classes and each class time-block was randomly assigned to a treatment.

At the break-out session before the study and on first day of the study, the students were given the following information by their instructors:

> Our class has been selected to participate in a study that will look at the differences between individual and group practice . In order to have reliable results, it is critical for you to attend all three classes. You will receive 10 points for attending all three classes. But it is an all or nothing reward. If you miss even one of the classes, you cannot receive any points. ADDITIONALLY, the quiz on Friday will be worth 10 points.

All the students attended the same weekly mass lecture on Wednesdays, but were assigned to different break-out sessions that met on Mondays and Fridays. The break-out sections were taught by graduate teaching assistants and ranged in size from 25 to 45 students per session. The study ran during three 50 minute class periods, with the posttest being administered in the third class period.

During each class the teaching assistant lectured and used the worksheet problems throughout the lecture to illustrate the concepts being presented, as well as to provide practice for the students. The teaching assistant verbally provided content organizers as part of the class discussion that preceded practice in all groups. The researcher and teaching assistants had agreed upon the organizers to use on the worksheets, which were the same ones used most frequently by the teaching assistants in their lectures (E.g.,"Remember that debits equal credits; The accounting equation requires that assets equal liabilities and owners equity."). All students individually worked the practice problems before the teaching assistant lead the class in discussing and answering the problems.

In the peer collaboration groups, the individual work was followed by comparisons of answers between student partners. The students worked in self-selected teams of two. The teaching assistant gave the students instructions to "Work out your own solution and then consult with your partner". Each student spent about a minute working out his or her own solution to each problem and then about a minute collaborating on the answer. Each student had his or her own worksheet.

In the individual practice treatments, the students worked on their problems by themselves for about two minutes. In all the treatment groups, the teaching assistant lead a discussion and answer process of solving the practice problem after the students had worked on a solution.

The content organizers were listed and circled in the margins of the worksheets used by the Content Organizer groups (eg., DR = CR; A = L + OE). The teaching assistant verbally included the organizers in both the lecture and the discussion sections for all the classes. The written organizers were not included on any of the worksheets on the last day of treatment. This change was made so that the group using the organizers would also receive practice without the organizers, since the test did not include any prompts.

Materials

Materials consisted of the required accounting textbook for the course, overhead transparencies prepared by the two teaching assistants, and the experimental practice worksheets. The teaching assistants met with the researcher prior to the study and reviewed the content, structure and wording of the practice worksheets. Each teaching assistant used overhead transparencies which they individually prepared by summarizing key content points from the textbook. The content and presentation of the overheads were comparable. The practice worksheet problems were based on homework problems from the textbook.

Criterion Measures

Results were measured by a 40 item posttest, administered on the last day of treatment. The tests were scored by the researcher, who is an experienced accounting instructor and a CPA. The test covered the content of the accounting lessons taught during the study. The K-R 21 reliability for the posttest was .89, indicating high reliability of measurement. The teaching assistants converted the 40 item posttest into a quiz score of one to ten points, consistent with their weekly pattern of ten-point quizzes. The test contributed to the student's grades as one of 12 quizzes given throughout the semester.

Students also completed a 12-item Likert-type attitude survey, scored from 1 (Strongly Agree) to 5 (Strongly Disagree). The survey also contained two open-ended questions.

Design and Data Analysis

The research design was a 2 X 2 posttest-only factorial design. Data were analyzed using a 2 x 2 analysis of variance comparing posttest performance across practice modes (peer collaboration and individual) and content organizer treatments (organizers versus no organizers). Data from the attitude questionnaire were analyzed for variations in responses between the peer collaboration and individual-work groups.

RESULTS

Table 1 shows mean scores were 27.3 for peer collaboration and 23.2 for individual practice. The difference in favor of peer collaboration was statistically significant, $F(2, 167) = 5.12$, $p < .007$.

Insert Table 1 here.

As shown in Table 1, mean scores for the content organizers and no content organizers were 27.8 and 25.2, respectively. This difference approached, but did not reach, the .05 level of significance, F (2, 167) = 3.53, p <.062. The interaction was not significant for practice mode by content organizers.

Four significant differences between practice modes were found in student attitudes. Students in peer collaboration groups (mean = 2.07) responded significantly more favorably to the question "Do you think it helps you understand accounting to consult with a partner?" than did students in individual treatment groups (mean = 2.68). When asked "Do you think it helps you learn more if you explain your answer to another student?" students in peer collaboration (mean = 1.88) responded significantly more favorably than did students in individual treatment groups (mean = 2.54). The reaction by students in peer collaboration was significantly more favorable to the question "By using the practice worksheets, did you find it easier to understand your TA's lecture?" (means = 1.98 and 2.41, respectively). However, students in individual treatment groups (mean = 3.83) responded with significantly stronger disagreement to the question "Did using the practice worksheets take away time that should have been used for your TA's lecture?" than the peer collaboration groups (mean = 3.39).

The student comments on the two open-ended questions yielded some common themes. The first question asked the students "What three changes would you make to Introductory Accounting to make it easier to understand?". The most common answers were 1) More time in class , 2) Less content coverage ("goes too fast" or "slow it down"), and 3) Cover materials/concepts before homework is assigned or due. The second question asked for student comments and reactions to the research study. Many students commented that the research was a "good idea" and "talking about it made class more interesting". Students remarked that the worksheets were helpful, as was working with a "partner", because "Two heads are better than one" and "It helps to talk about it and correct your own mistakes."

At the end of class on the last day of treatment, students were invited to attend a de-briefing session to discuss the study. A total of 40 students attended the session on their own time and participated very actively in sharing their attitudes about the method of peer collaboration. By a show of hands vote,they overwhelmingly endorsed the method (37 to 3). Group consensus focused on three changes to improve the classroom application of the study. Students felt the teaching assistant should assign the teams, rather than allowing the students to choose. They also thought more time should be allowed to consult on the answers. Students recommended that time be spent in class for training and instruction in group work prior to working in teams.

DISCUSSION

The significant differences in achievement by the peer collaboration group that were obtained in this study, combined with the positive attitude findings, are encouraging for additional work with peer collaboration. Several factors may have contributed to the positive results for peer collaboration. These include providing and explaining the answer, obtaining feedback and discussion, and playing an active role in learning.

Students working with partners interacted by giving and explaining their answer, as well as by receiving their partner's answer. This kind of interaction may also provide a experience necessary for developing the kinds of consultative skills needed in the accounting profession. The peer collaboration practice mode may have provided the possibility for further processing of information. Kulhavy, et al (1988) found that greater time spent encoding information into working memory results in deeper processing and, in turn, better recall of information. The peer collaboration mode certainly offered the opportunity for more active processing of information, which could have led to better recall by the peer collaboration group.

Another important aspect of the study is the possible power of collaboration after working alone. Students initially worked alone and then consulted with their partner. This form of peer collaboration or consulting combines individual learning with group interaction, which may have more application to the business world which the students plan to enter. Patten and Doyle (1990) urge accounting educators to fashion the accounting education experience to include more situations where students learn to work together.

Learning to collaborate may also provide the learner with a greater sense of active participation in the subject matter. The aspect of being engaged in the class activities is increased when student interaction can be fostered (Webb and Cullian, 1983). In many accounting courses, the pace of content coverage is deemed to be too fast by the students, but they are hesitant to say so in class. However, once the students are more actively involved in peer collaboration, they are also more willing to ask questions of the instructor.

A good by-product of active learning may be a more positive attitude towards learning, on the part of both instructor and student. Positive attitudes from this study appeared to encourage more student involvement and participation during class discussions. Students felt they learned more by working together in class, which might also provide more relevance and confidence to students. Peer collaboration may provide a source of continuing motivation for the students.

The teaching assistants also felt the use of peer groups increased their enjoyment of teaching. Both teaching assistants continued to use the peer collaboration practice mode throughout the rest of the semester, and received positive student feedback on it on the student evaluations at the end of the semester.

Based on the results from this study and due to the major curriculum changes being made in the School of Accountancy, peer collaboration is now being included as a standard class practice method, with much success. The new introductory courses will have the majority of all class activities conducted as collaborative work. Additionally, the use of peer collaboration is being investigated for the new computer lab course.

The content organizers on the practice worksheets did not result in a statistically significant difference, although the difference did approach significance. Whether such an approach is effective is still unclear. Perhaps if students had been trained in how to use the organizers, a stronger effect may have occurred. Ellis, et al

(1986) distinguish between specific and generic organizers and suggest that more structured instruction is needed for the learners to effectively use content organizers.

The content in a number of subjects involving applied skills often lends itself well to a peer collaboration method. For example, mathematics, statistics, lab sciences, even spelling, could use this method for class practice. The results of this study suggest peer collaboration is effective in producing a higher level of learning and appealing to the students. Students showed higher levels of achievement under peer collaboration and they had significantly more positive attitudes toward this practice mode.

Classroom application and research study continue to increase in the area of cooperative learning. The present study raises questions that are appropriate for further investigation in peer collaboration. Does peer collaboration work better when more time is allowed for the consulting phase of practice? Is peer collaboration or consulting a way to combine individual accountability and team work, thus simulating the working situations many accounting students will encounter upon graduation? Would training in the most effective ways to work with a partner increase the learning benefits?

The results from this study indicate that peer collaboration is an effective method for use in the technical areas of accounting. Further research and applied study using peer collaboration can help us to understand its most effective uses to improve accounting instruction.

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TABLE I

Test Mean Scores and Standard Deviation by Treatment

CONTENT ORGANIZERS	PRACTICE MODE		
	Peer	Individual	Totals
Organizers			
M	28.5	24.4	27.8
S	7.6	6.6	
No Organizers			
M	26.0	22.4	25.2
S	8.3	10.2	
Mean Totals	27.3	23.2	26.5

Title:

Multimedia: A Gateway to Higher-Order Thinking Skills

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Multimedia: A Gateway to Higher-Order Thinking Skills

A Work In Progress

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BACKGROUND

The onset of the information age has made it imperative that learners develop higher-order thinking skills. Research is just beginning to reveal the full power of multimedia technologies to address this need as it focuses on the amalgamation of multimedia attributes rather than on the significance of any one characteristic. Multimedia technologies can contribute to the development of higher-order thinking skills because they facilitate: learning via structured discovery, student motivation, multiple learning styles, the navigation of web-like representations of knowledge, learner authoring of materials, the collection of rich evaluative information, and collaborative inquiry. The educational reform movement is providing momentum for change at the same time that multimedia devices are finally becoming affordable to schools. It is within the context of this evolving educational environment that we undertake the Multimedia and Thinking Skills Project in order to demonstrate a new paradigm for inquiry-based learning.

In June of 1990, the research group at George Mason University's Center for Interactive Educational Technology (CIET) began designing a multimedia prototype to foster higher-order thinking skills in the social studies. As an initial step toward that objective, The Civil War Interactive Project using Ken Burns' documentary, *The Civil War*, as the core of a multimedia database produced a design demonstration. This computer-based instructional system teaches a systematic process with which to develop higher-order thinking while learning how to engage in historical inquiry. With funding from the Corporation for Public Broadcasting and technical assistance from Apple Computer, the team took the first steps toward the ultimate goal of creating a generic instructional shell. This shell will be carefully conceived so that it empowers learners by giving them a tool that promotes the development of thinking skills as they acquire bodies of knowledge. We believe that this model of inquiry can be easily adapted to multimedia content across a range of disciplines, from science and mathematics to the social sciences and humanities.

As this initial project has progressed, four themes are providing a long-range focus for our work:

- The multimedia shell for teaching thinking skills is adaptable to material from a variety of disciplines.
- Design heuristic are emerging about how to design multimedia tools that give teachers leverage on the difficult issues of cognition, learning styles, motivation, cooperative learning, evaluation, and the unique needs of at-risk students.
- The quality of multimedia databases, particularly the quality of the video, is an important factor in creating effective multimedia prototypes that provoke higher-order thinking.
- Professional development activities that utilize innovative distance learning technologies such as on-line databases, teleconferences, and computer networks are central to successful utilization of multimedia products.

RATIONALE

In a world where the amount of data increases exponentially each year, a major challenge for schools is to prepare learners to access and use information effectively. Information management skills have never been more vital for students entering the work force. The computer has become an integral part of doing science and is quickly becoming a fact of everyday life. Computers generate vast amounts of technical data and the emerging information networks provide access to overwhelming amounts of information. However, learners frequently become lost in a morass of data and information and without higher-order thinking skills, they cannot synthesize large volumes of information into overarching knowledge structures. Unfortunately, rich technologies such as multimedia are often being used only to provide access to even more data in which learners can drown, thus exacerbating current problems rather than contributing to solutions.

We believe the same technologies that are swamping learners in data can help them master the thinking skills that will promote the synthesis of information. This requires a refocusing of current uses of multimedia in the curriculum, from engines for transmitting massive amounts of data to tools for structured inquiry based on higher-order thinking. Such an approach should be equally applicable to science, mathematics, the social sciences, and humanities. The best role for multimedia in schools is not to augment data delivery in conventional instruction, but instead to foster a new model of teaching/learning based on learners' navigation and creation of knowledge webs through a formal inquiry process. Dede (1990b) suggests that higher-order thinking skills for structured inquiry are best acquired where:

* Learners construct knowledge rather than passively ingest information;

* Learning is situated in real-world contexts rather than based in artificial environment like end-of-chapter textbook questions;

* Sophisticated information-gathering tools are used to stimulate learners to focus on testing hypotheses rather than on plotting data;

* Multiple representations for knowledge are used to help tailor content to suite individual learning styles;

* There is collaborative interaction with peers, similar to team-based approaches underlying today's science;

* Individualized instruction targets teacher intervention to assist each learner in solving current difficulties; and

* Evaluation systems measure complex, higher-order skills rather than simple recall of facts.

DESIGN ELEMENTS

This project has identified eight elements to be addressed in the design of effective instructional multimedia products: explicit instruction, modeling, tutoring/coaching, student control, collaborative learning, equity, the quality of the database, and professional development. The generic computer shell will have five generic features: the IBI (Inquiry Bureau of Investigation), Guided Tours, Dr. Know, the Production Console, and Custom Tours. The IBI is literally an iconic bureau; by opening each of its drawers, students receive explicit instruction on the steps of inquiry. Guided Tours model the inquiry process by taking student through the database on carefully designed paths that pose questions and compel them to evaluate the extent to which the data they encounter helps to answer these questions. Dr. Know is the context-sensitive coach or tutor who helps students develop data-gathering and metacognitive skills. Custom Tours is a non-structured access system to the data that allows free-form searches based on students' interests and are in the students' control. The Production Console gives students the tools with which to manipulate the information in the database to make reports and create their own tours. It is not only a device for student control but it also facilitates collaborative learning. Other design element such as the quality of the database, equity, and professional development are discussed as environmental factors that must be considered if successful utilization of the shell is to be accomplished.

Explicit Instruction – Inquiry Bureau of Investigation (IBI)

The IBI is literally an iconic bureau; by opening each of its drawers, students receive instruction in the steps of inquiry. Because higher-order thinking is neither instinctive nor developed as a result of teaching only content, providing opportunities in subject matter instruction for students to use thinking skills is not enough (Feuerstein, 1980; Perkins, 1987; Sternberg, 1984;). Instead, students need continuing, deliberate, and explicit instruction in how to use inquiry skills — not in a decontextualized manner, but simultaneously with their striving to master subject matter (Salomon, 1991, Whimbey and Whimbey, 1975). Additional studies of database use in social studies (Ehman, Glenn, Johnson, and White, 1992; White, 1987) and hypertext use in science education (White, 1989) support the view that effective use of information by learners requires an array of thinking skill supports. In a study of word processing as a way to improve writing, Zellermayer, Salomon, Globerson & Givon (1991) indicate that courseware with guided instruction and continuous high-level cognitive help contributed to substantial improvement sustained over time and across technologies.

Modeling – Guided Tours

Guided Tours model historic and scientific inquiry. They are purposeful environments that deliberately present contradictory observations, reports, or accounts that inspire students to invent additional questions, hypothesize answers, and identify potential sources of data. We have incorporated into our design an anthropomorphic coach, Dr. Know, who acts in Guided Tours to facilitate learners developing inquiry skills.

As Scardamalia, Bereiter, McLean, Swallow, Woodruff, (1989) describe, students require extensive scaffolding to sustain active, constructive approaches to learning. Their approach centers on procedural facilitation of learning — not machine-based intelligence, but implicit structure and cognitive tools that enable learners to maximize their own intelligence and knowledge. In the context of multimedia, procedural facilitation requires the instructional system to present exemplary knowledge-structuring architectures, illustrative representational formats, and prompts that encourage expert information managing strategies. In our design, the Guided Tours provide the first two of these strategies for enhancing learning, and Dr. Know provides the third.

Tutoring/ Coaching — Dr. Know

In our prototypes, resident scholar or context-sensitive coach, Dr. Know can be called upon to assist students in developing data gathering and metcognitive skills at each stop along the Tour. Laurel, Oren & Don (1990) describe a variety of ways that interface agents serving as guides can reduce the cognitive load for users of multimedia systems. In Guided Tours, Dr. Know gives context-sensitive advice on how to explore a cluster of data, how to think through issues in an inquiry situation, and what questions may be most productive to pursue. In the IBI, Dr. Know gives systematic instruction on the steps of inquiry within the context of the tour. As Beyer (1990) notes, instruction about thinking skills at the time that they are contextually needed to achieve subject matter mastery motivates students to acquire these skills and enhances the quality of subsequent learning. White (1987, 1989) also notes the importance of the interactive coach in supporting skill development.

In many ways, we are wrestling with the same issues as the Cognition and Technology Group at Vanderbilt (1990) who are examining the concepts of anchored instruction and situated cognition. They are creating instructional systems for various domains that permit students and teachers to experience inquiry through the actions of an expert. Our Dr. Know is an expert scientist or historian who takes learners (whom the Vanderbilt Group might describe as apprentices) along on an investigation. Through modeling, Dr. Know helps learners develop their skills and knowledge. This investigative setting for anchoring instruction in an authentic context enhances learner motivation and makes the skills more likely to generalize into real-world environments.

For subject-independent material such as the IBI, Dr. Know's help transfers across disciplinary domains. For specific Tours in a particular subject, this context-sensitive help must be customized from generic templates by the instructional design team creating the multimedia materials for that domain. Dr. Know does not have generative capabilities, so is not an intelligent coach; the complexity of developing a discipline-independent, glass-box, knowledge-based system would exceed the benefits such a feature could provide. Because the inquiry model is generalizable across disciplines, our preliminary work indicates that small canonical variations of prompts make Dr. Know easily adaptable to a wide range of subject domains. Unlike the group at Vanderbilt, we have also incorporated explicit as well implicit instruction in inquiry.

Student Control -- Custom Tours

The environment we are developing supports instruction in which students have some freedom of choice — including producing their own reflective multimedia materials as an outcome measure indicating mastery — and in which they work in small groups using collaborative inquiry to explore and master multimedia material. In Custom Tours students can use the facilities of the Production Console (described below) to create their own path through the data.
Once students feel they know the inquiry process, they are encouraged to design their own Custom Tours. As students take more responsibility for their own learning, Dr. Know prompts them to state Thoughtful Questions and hypotheses that will help them establish what Scardamalia et al. (1989) term goal orientation. A major objective of the goal orientation strategies Dr. Know conveys is to de-emphasize the tendency of naive learners (and teachers) to rehearse or memorize information; instead, stress is placed on skills that allow data to be reconfigured as needed.

Helgeson (1987) establishes the importance of student freedom, choice, and the use of small groups as effective in improving scientific problem-solving behaviors. However, while freedom for students to navigate and explore knowledge webs is important, our prototypes will also provide extensive implicit structure via Guided Tours through the multimedia database. As Rivers and Vockell (1987) indicate in their study of computerized simulations and problem solving skills, students using guided versions of simulations surpassed those using unguided versions on tests measuring cognitive processes and critical thinking.

Student Control -- The Production Console

Beyond the cluster of capabilities associated with Dr. Know and the IBI, the multimedia/thinking skills shell enables learners to produce their own multimedia presentation and Custom Tours. The Production Console is a tool to help students construct both Custom Tours built around their own Thoughtful Questions and Reports that document their proof/disproof of the hypothesis from a Guided Tour. In the Production Console, students take data in various forms --- video, audio, graphic, animation, text — that they have gathered in their Journal and manipulate them. Learners can add additional data external to the prototype, can analyze their journal entries based on the inquiry process in the IBI, and can author their own tours to augment those provided with the instructional system.

As Donoho (1986) notes, participation in audiovisual production contributes to student learning in curriculum areas such as language arts, social studies, and science. Students engaged in these production activities demonstrated improvements in self-concept, motivation, creativity, and attitude. In addition, these students increased their involvement with print media.

The Production Console is important for another reason: students use this feature to demonstrate their knowledge, their ability to analyze data and state conclusions, and their skills in applying what they have learned. To date, little work has been done on evaluating student outcomes from instruction with multimedia but a US Office of Technology

Assessment report (1987) indicates that, if technologies are to succeed in schools, teachers must have better methods of evaluating student outcomes. An objective of our project is to develop improved evaluative measures that can help teachers assess learners' mastery of inquiry skills.

Cooperative Learning

Capabilities such as the Production Console support cooperative learning because students can easily share and display data, comment on drafts, and keep collective records of their inquiry process. The production of multimedia tours is a particularly powerful vehicle for collaboration because learners must pool unique individual strengths (editing video, scanning images, digitalizing sound, creating animation, writing text) to develop a successful product. While there has been limited research on collaborative or cooperative learning in multimedia environments, Adams, Carlson, Hamm's (1990) review of the research indicates that collaborative learning with interactive technologies leads to higher scores on measures of content knowledge and observation skills, as well as high degrees of learner motivation and satisfaction.

Equity

Equity issues are an important theme underlying our approach to moving beyond traditional evaluation methods into innovative strategies that assess higher-order thinking skills and complex behaviors denoting mastery. Research suggests that current uses of information technology in education may be widening the gaps between rich and less affluent schools and between high-achieving and at-risk students (Ascher, 1984; McPhail 1985; Morgan, 1987). Public schools in impoverished districts and small rural schools are more likely to have high student/computer ratios, and wealthy schools tend to offer computer-based enrichment activities while financially stressed schools focus on computer-assisted remediation. Educational policy goals are clear in mandating that instructional technologies be made equally available to all students and in supporting efforts to address the needs of historically underrepresented populations.

In a recent summary of research on computers and at-risk students, Rockman (1991) notes that well-designed educational technology both enhances the achievement of at-risk learners and improves their attitudes toward school and the subject matter they study. Even though many of these studies warn of novelty effects on achievement and attitude outcomes, the research seems to indicate that at-risk students, using information technology, experience gains in linguistic fluency, subject matter comprehension, problem solving abilities, and mathematics skills. Attitudinal measures demonstrate higher levels of self-confidence and self-esteem, enthusiasm for the use of technology, and appreciation of the ability to control the pace of their learning (Clariana and Smith, 1988; David, 1986; Diessner, Rousculp, & Walker 1985; Edeburn and Jacobi, 1985; Ely, 1984; Henderson, Landesman, & Kachuch, 1983; Jacobi, 1985; Laboratory of Comparative Human Cognition, 1989; Mehan, Moll, & Riel 1985; Miura, 1987; Payne, 1986; Rosegrant, 1985; and Ross, Smith, Morrison, Ericson, & Kitabchi, 1989).

However, little research has been done that documents how multimedia technology can be designed to effectively build on the strengths and motivations of at-risk students. We believe that our multimedia/thinking skills approach offers promise for motivating students who find conventional instructional materials uninteresting because they are predominantly textual/symbolic, passive, linear, centered on memorizing data, and remote from issues learners find meaningful in their own lives. In particular, we hypothesize that multiple representations of knowledge to address different learning styles, collaborative inquiry to build on differential individual strengths, and active production of knowledge webs could reach students now uninvolved in classroom instruction.

Quality of the Database

As Kozma (1991) notes, the instructional effectiveness of any one medium varies with the nature of instruction and the nature of the learner. We are concerned with constructing a multimedia database that stimulates thinking and supports a variety of diverse learners as they construct their own cognitive webs. We draw from a very high quality video database for The Civil War Interactive Project, Ken Burns' film *The Civil War*, and augment it with a rich collection of primary source documents including photographs, diaries, audio tapes and maps. During the development of the project we will attend to the extent to which the nature and quality of the database affects learning for a wide array of learners.

Particular attention will be paid to the role of video. Research into the instructional effectiveness of video alone has not produced clear results, as Johstone (1987) notes, film and video are more works of art than feats of engineering thus making it difficult to quantify the qualities of film and video that make it affective in instruction. However, we do know that well-produced video helps to motivate students; Gibbon & Hooper (1986) found that video was a powerful force in motivating students to want to learn more science and mathematics.

In some previous educational multimedia products there has been a tendency to utilize "repurposed " video segments (segments originally intended for a completely different use) or to use segments of lower quality. Semper (1990) argued that the quality of the video segments employed in multimedia products affects the level of learning attained by users and that higher quality segments encourage greater involvement and thus more learning. Naimark (1990), Chen (1990), and Ambron (1990) agreed, with each citing the relationship between the quality of the video and the quality of the learning experience. Mountford (1990) accounted for this relationship by suggesting that "drama has the power to engage audience members both emotionally and intellectually" (p.21), while Florin observed that "because the footage is emotionally compelling, you want to learn more on the subject. . . . But what is most significant here is that the story gives you a reason to study the materials" (1990, pp. 36-37). In light of these concerns, our project draws upon powerful and informative footage with high production values, seeking to use powerful video segments as vehicles for learner involvement. The demonstration prototype of the Civil War Interactive Project utilized the powefull footage from Ken Burns' series, *The Civil War*, to draw students into the adventure of historical inquiry. Similarly, the other prototypes in the Multimedia and Thinking Skills Project will utilize well-produced footage that will draw learners into the study of science, mathematics or social sciences. We view video producers and others with extensive video experience as key members of our development team.

Professional Development

Excellent curricula that rely on non-traditional models of teaching/learning tend to fail unless support is provided for teachers to master the new paradigm for instruction (Havelock, 1970, 1973). As the prototypes are developed, we will assess the types of scaffolding necessary for teachers to use these materials successfully in a typical classroom without special resources or expertise. The professional development methods we envision include both conventional strategies (workshops, self-instructional kits) and innovative, telecommunications-based approaches such as videoconferences and networked virtual communities for providing support across barriers of distance.

The central focus underlying all these professional development efforts is to help teachers reconceptualize the purpose of disciplinary instruction: from memorization of facts to mastery of thinking skills and knowledge. Even with a sophisticated multimedia prototype to scaffold their instruction, teachers need extensive support to restructure their pedagogical approaches toward inquiry-oriented learning. In a study of teachers' critical thinking and performance in social studies, Fontana (1980) noted that success in improving students' critical thinking skills may depend on improving teachers' skills in integrating higher cognitive activities into their instructional planning and implementation.

One product of this project will be a plan that both details the scope and type of professional development needed to enable teachers to use our multimedia/thinking skills materials and assesses opportunities to use emerging information infrastructures to support ongoing instructional innovation. Dwyer, Ringstaff, & Sandholtz (1991) note that effectively integrating technology into the classroom requires changes in teachers' instructional behaviors. Over time, these behavioral changes occur as teachers reflect on their own beliefs about learning and instruction and as the administrative structure of the school shifts to accommodate these changes. These researchers also note that the nature of the support needed for teachers as they engage in the process of change alters at different stages of implementation.

For example, in early stages of innovation teachers' needs center on their concerns about the technology itself; skill development is the most important type of support. As adoption and adaptation proceed, teachers increasingly need opportunities to think about instructional issues and to engage in ongoing dialogues about their experiences.

Hunter (1990) points to the potential of computer-mediated communications to support teachers as they experience fundamental change in their instructional strategies and beliefs. Fontana and Ochoa (1985) caution that administrators need to provide supportive environments for change and require their own training and support system. Bruder (1991) outlines some of the current local and regional activities that use telecommunications to train teachers. Dede (1990a) describes trends that are making distance learning via telecommunications a reality in professional development. All this research underscores the need for the development of creative technology-based strategies for professional development.

The Thinking Skills Project views students as tourists through multimedia databases. Just as tourists make choices about how they will explore different sights, users of our multimedia/thinking skills shell can decide how to explore their cognitive environment. They may choose one of several Guided Tours or they can explore the database via Custom Tours. A reflective context for learning is created in the exemplary Guided Tours; these provide stimulating environments within which students become actively engaged in learning the subject domain while receiving context-sensitive instruction on the inquiry process. As students proceed through Guided or Custom Tours, they are able to call up their on-line tutor, Dr. Know, to help them evaluate information in various form. During their tours they collect information in their electronic Journal which they take to the Production Console. It is here in the Production Console where they consult the IBI and make certain they have followed all the steps; they are then ready to create reports or design their own tours.

Because it is so difficult to envision how the feature we have just discussed will work together to promote the development of higher-order thinking, we have included a short scenario that describes one way in which The Civil War Interactive Multimedia Product might be used in the classroom. This is just one of many optimistic visions of the potential classroom application of our work.

THE APPLICATION OF THE MULTIMEDIA SHELL: THE CIVIL WAR INTERACTIVE

Ron, Juan, and Kim are three students from Ms. Regis's class who have chosen to develop a cooperative inquiry project on the Civil War. Ms. Regis has suggested some potential topics the students might select and has encouraged them to pursue other topics once they can frame these in the form of Thoughtful Questions. The students were present when Ms. Regis briefed the class on using The Civil War Interactive; while Juan and Kim are excited and interested, Ron is not sure he wants to do much work. He really doesn't see how the Civil War relates to him and is not so sure about this new technology. While Juan and Kim are interested in the topic they are not entirely comfortable with the inquiry process or how to operate the instructional system.

Juan takes the lead with the mouse and enters the system hesitantly. On the opening screen, he identifies himself as a group leader for the "Yankees" and starts by reviewing the Guided Tour that Ms. Regis used in her class discussion. They choose the Tour which is guided by the Thoughtful Question "How are peoples lives affected by war?". They open the Guide book and see the four stops: Prewar Life in the South, Prewar Life in the North, The Portrait Gallery, and Life After the War. They decide to go further. Ron grumbles, "this is boring." He would rather do something else; after all, what does the Civil War have to do with him? He only half listens as Juan and Kim discuss the kinds of answers they might expect to find in response to the Thoughtful question.

He finally speaks up when Juan and Kim are trying to decide whether to go on this tour. Ron thinks that they should. At the next screen the group sees two hypotheses. The instructions on the screen indicate that they must choose one. Ron is not even sure what an hypothesis is, or why he should care. But as he looks at the second one, his interest is peaked and he encourages the students to choose the hypothesis that states:

> Individuals in the North and South were affected differently by the Civil War depending on their economic, political, social, and geographic circumstances.

They then decide to go to the first stop, Prewar Life in the South. They are unsure which of the sights to visit. Mrs. Regis comes over to see if they are having trouble and they tell her they are not certain what to look at first. She suggests that they might want to check with Dr. Know. By clicking on the icon at the bottom of the screen, a second screen pops up and lists three kinds of advice you can get: "E" or exploration advice, "T" or thinking process advice, or "Q" for more questions to consider. Ron wants to check the exploration advice. Juan says OK and turns the mouse over to him. He clicks and a screen then pops up that explains the relationship between the information found at the different sights and suggests that they begin with the Agriculture and Plantation System.

Kim is interested in the kind of thinking advice they will receive and asks Ron to go back to Dr. Know to get that advice. Here they get some suggestions about how they should be thinking about this information in relationship to their hypothesis. Back at the first screen of the first stop they take Dr. Know's advice and go to the plantation system. Another screen comes up with classifications of primary sources they can examine on Slaves, Plantations, Social Life, and Political Life. They choose to look at more information on slavery and find that they can explore documents, video shows, or photographs. Kim wants to see the comprehensive video essay. She remembers that Mrs. Regis showed some of it in class and she wants to see it again. The video monitor pulls up the footage from *The Civil War*; the music is Jacob's Ladder and then they hear the crickets as the camera explores the photographs of slaves working in the field. Then the narrator begins to speak as the camera focuses intently on the photographs of individual slaves on the auction block and slaves in chains.

Ron is now rivetted. He was not in class the day Ms. Regis gave the introduction. He had no idea how horrible slavery was. He had never been this close to it before. Kim comments that slavery is no longer just a word in a book. It was a horrible way to live. Ron is listening to the narrator give the statistic on the number of African Americans who lived as slaves and what life was like in a slave cabin. He can't take it all in. He stops the video and goes back and calls up the section on slave cabins again and hears and sees one more time how awful the ordeal really was.

They are about to go into more depth on the issue of slavery by examining the pension record of an African American woman, Susan Drane, when a prompt reminds them that they are on a Guided Tour and they might want to review where they have come so far and perhaps note other questions they have on this topic in their Journal for latter consideration.

The students agree, but they have forgotten the hypothesis. They think a minute and Kim realizes that all they need to do is to click on hypothesis at the top of the screen. Up it pops. She now wants her turn on the mouse. She clicks, up pops the Thoughtful Questions. Now they are not at all sure what to do. Juan suggests that they ask Dr. Know who, in turn, suggests that they review the pension record carefully looking for information on how the war affected African Americans in the South, and that they place that in their Journal. He notes that if they go to the Journal it will give them directions about how to capture video footage, copy text from the document, and how to write their own notes. They take the advice and work on composing their joint observations.

They return to the pension record and because it is 13 pages long, they decide to print it out and Kim agrees to read at home and mark the sections that they should keep in their Journal. She is really interested in how African American women lived under slavery and during Reconstruction. She thinks about the fact that her ancestors must have lived like this.

The students continue their Guided Tour over the next two days. They explore the video segments on African American troops, they meet John Boston and make a copy of his letter. They read part of Mary Chestnut's diary and then hear how she used the diary to help her cope with the war. They hear the words of U.S. Grant, W.T. Sherman, and Robert E. Lee and are struck by the fact that their letters home sound much like any other soldier who wants a war to end and to come home to those who love them. They also hear and read the words of Abraham Lincoln and come to know the pain of a man who is trying to hold his country together; yet not compromise an important principle like freedom. They learn how many of the founding fathers like Thomas Jefferson were just as tormented by slavery as Lincoln, while others felt that the issue of states rights was more important.

They have kept good records in their Journal and now have much to sort out. They move the Journal to the Production Console. Now what? They click on the Dr. Know and he suggests that they review the steps of inquiry by clicking on the drawers of the IBI (Inquiry Bureau of Investigation). They skip the Question and Hypothesis drawer and go directly to the drawer marked Testing Data.

They review the data they have gathered and then double-check their Journal taking note of the patterns. They then begin to apply the questions in the Testing Data drawer and discuss their immediate project.

> Is your data relevant or necessary to proving or disproving the hypothesis?
> Do you have sufficient data?
> What is the source of each piece of data? Is the source credible? Is it reliable?
> Does any piece of data incorporate bias or narrow points of view?
> Does each piece of data make a persuasive and logical argument?
> Are stereotypes represented?

The students are not familiar with the full meaning of each of the elements of the Data Test. However, by clicking on any step, they receive a brief description of that stage of the inquiry process and illustrative examples of how to apply that type of data test. The students complete the second day of their cooperative inquiry by eliminating some of the evidence they collected and by beginning to arrange the remainder in a form that addresses their hypothesis.

Ron and Kim have found some other charts and data in books in the library; they scan these into their Journal. The students now feel that they have enough data to begin writing their conclusions. They refer occasionally to the Concluding drawer, which helps them state their conclusions based on the data they have gathered. The group eventually comes to agreement with regard to whether they have proven their hypothesis true or false. They begin to compose their multimedia report.

They realize in the middle of the process that history and multimedia are more fun than they expected, especially since each member of the group can build on his/her strengths: Ron is the technical expert, Juan the visual editor, Kim the writer. In the process of using the Production Console to prepare the presentation, they realize how much they have learned. They discuss the fact that they had never thought about what life was really like under slavery. Ron is particularly amazed because he never liked history. Kim wants to find out more about African American Women and Juan enjoys sorting through the information and carefully selecting what will become part of their presentations. They all feel more confident about starting their next research project in history. They all feel that they have a deeper sense of what the Civil War was about.

They are anxious to show their work to Ms. Regis, who is very impressed with what they have done. She reviews the students' inquiry process and conclusions and then has them go through the inquiry check-list that is part of the evaluation strategy for student products. She then is ready to review their presentation and listen to their analysis.

(This scenario was adapted from The Civil War Interactive Demonstration and Project Design Document)

CONCLUSION

The Multimedia and Thinking Skills project described here is an ambitious one. It combines the development of an instructional multimedia products with the search for new knowledge about the potential of the technology. While looking to past research to inform design decisions, the project is not bound by existing models. The prototype products that we hope to produce will be more than rich multimedia databases with sophisticated navigational systems but will provide a glimpse into the future and help us all understand more clearly how to harness the instructional power of the emerging multimedia technologies.

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Title:

International Training Research Project Culturefax

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In the Spring of 1990, a team of researchers at Northern Illinois University began to compile findings from a study investigating the most critical audience factors impacting the design and delivery of instruction for international learners in higher education settings in the United States.

Results of early findings provided a direction for additional inquiry that is still continuing on the problems and challenges that face both learners from other cultures and their U.S. instructors in university environments.

Findings are being incorporated in small bulletins called "Culturefax" that are being distributed to higher education institutions and other interested parties. These bulletins note special cultural factors that may prompt U.S. instructors to become more sensitive and more effective in multicultural classrooms. These bulletins highlight, for example, if a certain nationality is generally more comfortable in group or team learning activities or in more individualized programs.

Other findings that have been useful in developing the highlights have been: the presentation style and even dress of the instructor, mediated materials preferences, personal treatment of the learners, use of glossaries to supplement existing texts for learners with language handicaps, timing and pace of instruction, and a dozen other factors.

It is important to discuss the findings of the studies and to review the methodologies. The researchers want to know the strengths and weaknesses of the techniques and usefulness of the results. The study and findings have been examined in some detail and comments on the procedures invited from the participants in several professional presentations.

The connection between the findings and the development of the bulletins have been incorporated in revised bulletins and recommendations from all the audiences will be considered for possible revision to continuing research and publication of the "Culturefax".

"Culturefax" is continuously reviewed with the intent of incorporating the audience critique in subsequent publications. Those who are critiquing the bulletins have a multicultural educational background and act as consultants to this project. It is hoped that this will be a multicultural and interactive activity that will provide a arena for the researchers and the participants to actively continue the research process and thus play a major role in the revision and reshaping of the final publications. This process suggests a robust means of validating the research, the bulletins and subsequent multicultural instructional techniques.

Sample handouts that capture the research and examples of the multicultural instructional bulletins are provided, and cover such themes as:

1. Platform skills in the multicultural education setting
2. Selection of appropriate media
3. Pacing and timing of instruction
4. Treatment of learners
5. Special cultural factors or religious, political or social considerations
6. Instruction in English factors
7. Subject matter issues
8. Classroom environments.

Subsequent reviews will focus on summarizing revisions and recommendations for adjusting the on-going research and on considering suggestions for improving the format of "Culturefax".

ORIGINATION OF THE THEORY OF CROSSCULTURAL INSTRUCTION

Key theoretical constructs that generated the research were suggested by the work of Philip R. Harris and Robert T. Moran and reported in a book entitled: *Managing Cultural Differences: High-Performance Strategies for Today's Global Manager*, 2nd Edition, 1987. Gulf Publishing Company. (ISBN 0-87201-161-5).

In the text, the authors posited several categories of cultural conditions that can impact learning by adult internationals in U.S. classrooms. These became the general areas of inquiry that the study attempted to address.

The conditions are as follows:

SENSE OF SELF AND SPACE

COMMUNICATION AND LANGUAGE

DRESS AND APPEARANCE

FOOD AND EATING

TIME

RELATIONSHIPS

VALUES AND NORMS

BELIEFS AND ATTITUDES

MENTAL PROCESS AND LEARNING

WORK HABITS

Additionally, Harris and Moran stated that the cultural impact on learning could be further refined to cover educational sub-heads:

TEACHER PERCEPTION

ENGLISH PROFICIENCY

CLASSROOM ATTITUDES OR BEHAVIOR

PERSONAL VALUES

OTHER

These categories and subheads were analyzed and formed into statements that could by tested for specific cultural groups. The initial intent was to clarify these statements to determine if they would generate responses that could be developed into hypotheses. The final outcomes would not be facts, findings or generalizations but rather testable statements derived from the collection of answers.

The categories and subheads were presented to representative international students at

Northern Illinois University and the responses tabulated and condensed to form the hypotheses.

This approach was also recommended in a dissertation by Dr. Jeanne Hites entitled: *Design and Delivery of Instruction for International Trainees: a Case Study*, Northern Illinois University, Spring, 1990. Dr. Hites suggested the development of testable statements for A.T. & T. instructors who were involved in the teaching of technical switching systems. She also employed a process termed: "triangulation" to confirm that the statements from international respondents were as valid as possible.

So, using "triangulation" that included student comments, previous instructors' comments and any written or anecdotal data available, she generated hypotheses that could be tested by in-service instructors at A.T.&T. This puts research on international teaching/learning at the appropriate and most relevant level: the classroom; and, provides the investigator with very reliable and valuable hypotheses that can be tested and possibly subsequently lead to improved classroom instruction and learning. It also attempts to avoid the so-called, "Margaret Mead" error of generalizing too extensively from respondents without other types of corroborating evidence.

This "triangulation" method using students as respondents, instructors as informants and written or anecdotal information in support of each statement or hypothesis was utilized in this study. As mentioned earlier, the statements have been put into bulletins entitled "Culturefax", and will be provided as requested to interested instructors, instructional designers and others.

Currently three cultural/national audiences have been examined and pilot "Culturefax" bulletins produced. These are: Philippines, Thailand and Indonesia. In addition to the printed bulletins a "LINKWAY", that is IBM interactive instructional program, is available for the Philippine's version of "Culturefax". Future interactive programs are being developed for several other "Culturefax" as well. In summary for publication this Spring are: Malaysia, People's Republic of China, and Kenya. Later bulletins will cover: Taiwan, South Africa and Egypt.

The initial audiences were selected as a function of being the predominant nationalities served by the faculty of Instructional Technology at Northern Illinois University, DeKalb, Illinois.

Plans included distribution to other units in the university and to the public at large for a small fee to cover printing, handling and mailing. Additionally, research on other specific audiences will be undertaken on request and workshops on preparing U.S. instructors for the international classroom provided by contract.

The following sample of the Philippine (Filipino) "Culturefax" provides a good example of the results of this international learner study.

RECOMMENDATIONS FOR THE FILIPINO CLASSROOM

1. Expect to be treated with "regard and respect".

2. Don't rely on instruction based on argumentation.

3. Be polite and somewhat formal.

4. Provide learning activities that focus on reading and writing but expect fairly fluent spoken English with some accents.

5. Avoid intense or "heavy" discussions.

6. **Keep changes, confrontations and disturbances to a minimum.**
7. **Give recognition, incentives and encouragement whenever possible.**
8. **Relate to the student in a "warm and personal" way.**
9. **Use lecture and rather direct instruction.**
10. **Test with essay and objective techniques.**

USING "CULTUREFAX"

Recommendations for the classroom are drawn from comments and observations by respective international students and their U.S. instructor as well as reports from other documentation. This does not guarantee that they are appropriate in all cases. The data that support the recommendations are valuable but subject to errors that accompany any research that relies heavily on informants and interpretations.

Use the recommendations as experiments. Consider the recommendations as classroom hypotheses that you can confirm or refute for your specific teaching environment. You are the best evaluator of these suggestions for your learners. If you find that the points are not useful to you, disregard them and write to us and tell us your findings. It is important to provide the most effective and current recommendations possible. Your observations will play a part in updating and revising future "culturefax". Thank you for your help.

OTHER FACTORS THAT DEFINE THE FILIPINO LEARNER

Teacher Perception

Filipino students respect authority. Instructors are considered authority figures in their respective fields. Students look up to teachers with high regard and respect. Students are expected not to question, disagree, argue, or challenge their teacher's viewpoints.

Students address their teachers in a polite and formal way. They use titles such as: "Sir, Mam, Mr., Mrs.,Dr., etc." Being in an informal classroom setting would make a student uncomfortable. Students also need to feel that they are respected by their teachers.

English Language Proficiency

Most Filipino students speak English well because they have had their basic background courses taught in English. But English is not the native language.

Some students may have difficulty expressing ideas in English. Filipino students read and write English better than they speak it.

Some students have distinct accents when speaking English.

Classroom Attitude

Students do not easily volunteer ideas, express opinions, or raise questions.

Filipino students are not very verbal, forward, or assertive and frank. They have a tendency to be shy or quiet. They prefer writing things down. They avoid heavy discussions.

There is also the tendency to be submissive by agreeing, avoiding confrontations, changes and disturbances. Students want to have a smooth interpersonal relationship with others.

Personal Values

Students like to be given compliments, incentives, encouragement, recognition, and acceptance.

They like those teachers who show interest in their progress and relate to them in a warm and personal way.

Be careful of the comments and jokes made in class. They might be more insulting than funny.

Others

Students prefer essay type of questions/examinations or a combination of objective and essay.

They are used to lecture type of interaction. Filipinos can adapt to their environment easily.

Sense of Self and Space

Filipinos are very private and do not open up easily to other people.

They like to work on their own.

They do not volunteer information.

They function well in situations when they are given their own space, independence.

Filipinos are mostly sensitive and emotional human beings.

Communication and Language

Talalog is the national language, but English (which is the medium of instruction) is frequently used especially in the business, education and the mass media.

There also exists urban and rural slangs and jargons; also regional dialects.

For Filipinos, their written English is better than their spoken English.

Dress and Appearance

Differences exist between urban and rural attire. Urban styles are Western influenced, while rural people wear simple work clothes.

Most business settings require certain dress codes.

Filipinos are conscious of their physical appearance and dressing up well relates to one's status and good family breeding.

Food and Eating Habits

Regional differences are evident even in food.

Rice is the staple food; food is generally not that spicy; people are fond of sweets for dessert.

People generally use forks and spoons but some still prefer using their hands.

"Burping" is not a sign of being disrespectful but that one had a very fine meal.

Some don't eat meat due to religious beliefs.

Time and Time Consciousness

The Philippines is known for "Filipino time" - not being punctual.

Most people try to be more punctual when it comes to business meetings.

"Manana" is commonly practiced.

Relationships

Strong family ties are evident among Filipinos.

A nuclear family may even include the grandparents, cousins, uncles, etc. and other immediate relatives and also what they call "adopted relatives".

Men/women or boy/girl relationships are also geared towards the family.

Fixed marriages are not prevalent but in some regions parents still engage in this set-up.

Pre- and extra-marital activities and living-in are taboo.

Long engagements are still preferred.

Manifestations of affection in public is considered inappropriate.

Values and Norms

They respect elders or any authority figure.

People are expected to behave in particular ways in relation to their economic status, profession or educational accomplishment.

Beliefs and Attitudes

Filipinos are predominantly Catholics in religion.

Religious authorities or superiors play a big role in influencing decision making.

There also exist beliefs in the supernatural, in superstitions, fairies, dwarves, gods and goddesses.

Mental Process and Learning

Early in life, Filipino children are taught by their parents basic readiness skills needed in school. Depending on the subject matter, teachers engage in either drill and practice or rote memorization. Individualized learning dominates the classroom setting encouraging the students to work on particular tasks at their own pace/level. As students go to higher levels of education, teachers encourage students to engage more independent and creative thinking.

Work Habits and Practices

They respect their superiors and tend to obey and follow them even if it means doing something they "don't readily believe in or agree with."

Some don't mind working extra hours or working late or even working during the weekends just so they could accomplish a particular task.

Most prefer the onset of new technology in the workplace while others still prefer manually operated or less sophisticated equipment. Changes are not easy to deal with in routine activities.

Nepotism is evident and payment is expected for favors especially in conducting business deals; loyalty to job is evident especially in the educational system.

The work place serves as a social arena.

Organizations often plan social events.

FINALLY

It is very important to validate the "Culturefax" by the means at our disposal. It is important for the statements or hypotheses to be valuable, and for the recommendations to be useful. With this in mind, this study and prospective publications are being presented to scholars of international education at several professional meetings to provide additional insight into the process for generating the statements and for assessing the merit of the product. The observations will then become an additional and very important aspect of the research "triangulation".

Your comments and ideas are most welcome and will be considered in the revision of the process and the resultant "Culturefax".

PLEASE SEND YOUR COMMENTS

CULTUREFAX

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Title:

The Effects of Modeling to Aid Problem Solving in Computer-Based Learning Environments

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Abstract

This study is an investigation of how modeling aids learners in developing problem solving skills within a computer learning environment. The task given to 45 subjects was to solve a crime in the computer game, Where In Time Is Carmen San Diego. Three subject groups received one of the following treatments: Expert Model, Novice Model, or No Model. Modeling entailed subjects viewing a computer-based animated and narrated movie showing how either an expert or novice completed the task. Results of the study indicate that modeling does not have an effect on the performance of participants, however it did contribute to the development of cognitive skills.

The Effects of Modeling to Aid Problem Solving in Computer-Based Learning Environments

The capabilities offered by computer-based learning (CBL) systems have led to significant innovations in instructional delivery systems, specifically in the design of simulations, demonstrations and drill-and-practice. The design of many CBL programs is linear and systematic. However, new paradigms for implementing CBL, such as hypermedia, require new design models and prescriptions to guide the development of instructional systems.

This study focuses on the instructional method of modeling and its application in a CBL environment. It is imperative that the importance of modeling is not misunderstood. We believe that there is a need for a more effective way to facilitate cognitive learning in a CBL environment, and that modeling delivered by computer is a strategy with considerable potential. Specifically, we want to determine how computer-based modeling of strategies within a CBL environment influences the acquisition of cognitive skills.

Theoretical Background

The history of modeling includes such theorists as Miller & Dollard, Bandura, and even Aristotle. Their work focused mainly on the concepts of imitation and observational learning. Aristotle noted that an individual, "Is the most imitative of living creatures, and through imitation learns his earliest lessons; and no less universal is the pleasure felt in things imitated." (Butcher, 1922, p. 15) More recently, the social learning theorists Miller and Dollard (1941) offer a cogent description of the role of imitation and social learning, emphasizing that imitative learning is an acquired social behavior. Bandura (1971) conducted extensive research on psychological modeling in the behaviorist realm.

A comparison of definitions of modeling is useful for isolating attributes of this instructional treatment. Bandura (1971) describes modeling using a broad range of terms, "Among the diverse terms applied to matching behavior are 'imitation', 'modeling', 'observational learning', 'identification', 'internalization', 'introjection', 'incorporation', 'copying', 'social facilitation', 'contagion', 'and 'role taking'" (p. 3). Romiszowski (1981), on the other hand, gives an apt description of modeling as the showing, not telling, a learner some set of processes, steps, skills and strategies to solve a task. Davies (1981) and Gagné (1987) define modeling simply as "demonstrations."

More recently, Welsh (1992) differentiates two types of modeling, behavioral modeling and cognitive modeling. We've attributed behavioral modeling to much of the research we've illustrated in the preceding paragraphs. Cognitive modeling, on the other hand, incorporates systematic verbalization on the part of the model to make his or her thinking processes visible to others. Thinking aloud and mental modeling are two strategies that describe what occurs during cognitive modeling.

Behavioral Modeling Research

"Algorithms guarantee solutions: if properly carried out they always yield the correct answer." (Perkins, 1986:198). Demonstrative modeling is, in essence, an algorithm, since it is the objective of the modeler to show the learner the perfect solution to the problem. The research has consistently shown that demonstrative modeling strategies for completing tasks have yielded greater performance than no modeling (Yaeshima, Ninomiya, Ohnogi & Oda, 1982; LaNunziata, Cooper & Hill, 1985; Rivera & Smith, [illegible]87; Baggett, 1987; Smith & Hailey, 1988; Robert & Chaperon, 1989).

Smith & Hailey (1988) found that demonstrative modeling techniques resulted in better performance in learning breast self-examination over narrative explanation and written instructions. In their experiment, the experimenters assigned 60 college women to one of three instructional treatments: actual breast demonstration, synthetic breast demonstration, and no demonstration. After one month, the two subject groups who received the demonstration treatments performed better than the control group. Yet after three months, all differences between experiment and control subjects disappeared.

Baggett (1987) investigated the use of a narrated film and a correctly assembled object as stimulus in the task of assembling a toy helicopter from a number of given pieces. The modeling by film consisted of a 15 minute, narrated 8mm film showing an expert naming and putting together the pieces to assemble the helicopter correctly. The assembled object was a completely assembled toy helicopter. Baggett found that any combination of film and the assembled helicopter resulted in greater task completion than either treatment in isolation.

Robert and Chaperon (1988) conducted a linking experiment between behavioral and cognitive modeling. In their experiment, they used a Piagetian horizontal representation water-level task with college women. Experimenters randomly assigned women to one of three groups: cognitive modeling, exemplary modeling and no modeling. Cognitive modeling entailed watching a videotape of a woman as she correctly solved three water-level tasks. During her solution, she both demonstrated and verbalized her actions. Exemplary modeling used the same videotape of the woman performing the task, however she never voiced any part of her solution. The no modeling group received no modeling of the task. Experimenters immediately evaluated subjects after treatment on their ability to solve a similar task with the same water bottles and a task with different water bottles. Fifteen days later, experimenters conducted a delayed post-test to measure stability of the learned behavior.

The results from this experiment clearly showed the impact of both cognitive modeling and exemplary modeling in enabling women to master the water-level task. However, the cognitive modeling component appeared to be the critical component that fostered improvement in the learner.

Cognitive Modeling Research

There is still the question we raised earlier of the technique one uses to model cognitive processes--i.e., think-aloud or mental modeling. Schoenfeld (1985) uses think-aloud routines to model the cognitive process of solving math problems. He has an ongoing contest whereby students present math problems for him to solve. In solving the problem, he thinks out loud, articulating his strategies for solving the problem. In essence, he is showing the students how he thinks in seeking a solution to a math problem, exposing them to all the complexities, mistakes and pitfalls one must deal with along the way.

In teaching reading skills to biology students, Mikulecky, Clark and Adams (1989) evaluated modeling as a means of coaching college freshmen to read texts more strategically. In particularly, they used computer-based presentations of text and analysis to model strategies such as identifying key concepts, writing linking summary statements to compare and contrast key concepts, and graphically mapping relationships among key concepts. They found that modeling these reading skills for biology students with a CBL program yielded higher exam scores over a control group that did not receive the CBL lessons.

Mandinach (1987) compared discovery learning and participant modeling as a method to develop strategic planning knowledge. Two groups of seventh and eighth grade students played a game called Wumpus. The experimenters used a discovery learning paradigm for one group, while the other group received participant modeling that systematically modeled appropriate cognitive skills and strategies. Students in the participant modeling group performed better in task completion; however the discovery learning group performed better in the transfer of skills to other tasks.

Synthesis

Between both behavioral modeling and cognitive modeling, the key instructional elements that comprise models are demonstration and verbalization. While demonstration is an established construct, verbalization is somewhat more undefined. For example, in Robert and Chaperon's (1988) research, verbalization was operationalized by describing one's actions during a perfectly demonstrated task. On the other hand, Schoenfeld (1985) also verbalizes his solution to math problems, however this verbalization includes the mistakes he is making and how he resolves those mistakes. We believe the demonstration of mistakes and verbalization of how to recover from them is a more effective instructional strategy for facilitating the development of cognitive skills than modeling perfect solutions. Thus, our research will investigate the differences between these two verbalization strategies in the context of cognitive modeling within CBL.

Hypotheses

On the basis of the literature, we expect our study to replicate the findings of prior modeling research.

H1: Participants who are shown a model of how to perform a task will perform better on that task than participants who are not shown a model.

How we define the protocol for modeling of cognitive processes is important to developing our study. Our primary concern is how experts think about solving tasks, and how to teach those thinking skills to others.

In the context of prior modeling research, we've developed two constructs for modeling. The first construct is the expert demonstration model, whereby an expert demonstrates and explains how to perform a task perfectly. The second construct operationalizes one of the salient features of Schoenfeld's research, namely the modeling of how to deal with errors. In this construct, a novice performs a task while an expert provides commentary on the novice's performance.

The showing of incorrect solutions is an important distinction to make between expert and novice modeling. Expert modeling, as described in the literature, tends to show the correct performance of a task, whereas novice modeling shows both correct and incorrect (with recovery) solutions. People make mistakes every day, and learning how to recover from those mistakes is an important skill. We believe the observation of a novice's recovery from incorrect solutions contributes greatly to acquiring cognitive skills. Therefore, we predict that novice modeling will result in successful completion of a task over the expert model since the participant will learn how to avoid and recover from common mistakes novices tend to make.

> H2: Participants who observe a novice model while listening to an expert comment on the novice's performance will perform better in a task than participants observing an expert model.

Performance is not the only measure of success. Our interest in the cognitive skills a learner acquires as a result of instruction drives our belief that modeling will have a positive effect on the key strategies a participant uses in solving a task.

H3: Participants who observe a model will use key task strategies more effectively than participants who do not observe a model.

H4: Participants who observe the novice model will use key task strategies more effectively than participants who observe the expert model.

Another measure of a learner's cognitive skill is articulation. Collins, Brown & Newman (1988) suggest that having a learner articulate what they know, by explaining how they plan to solve a problem or why they applied a particular solution, one can get a sense of the cognitive skills they've learned. Thus, we will investigate how the different modeling treatments affect the participant's articulations.

H5: Participants who observe a model will have stronger articulations about how to solve a task than participants who do not observe a model.

H6: Participants who observe the novice model will have stronger articulations about how to solve a task than participants who observe the expert model.

H7: Participants who have strong articulations will use key task strategies more effectively than participants who have weak articulations.

H8: Participants with strong articulations about how to solve a task will perform better in a task than participants with weak articulations.

Method

Design

The experiment was a 1-by-3 design. There was one variable, modeling, with three levels. The levels were expert, novice, and control. The expert level consisted of a modeling presentation showing an expert playing Where In Time

Is Carmen San Diego (WITICSD) with the expert's vocal narration. The novice level consisted of a modeling presentation showing a novice playing WITICSD with an expert's vocal analysis of the novice's performance. The control level consisted of no modeling presentation.

Participants

Fifty-two undergraduate and continuing education students from an introductory computer course at a large midwestern university signed up to participate in the study. The course instructor awarded extra credit to the participants for participation. We screened participants for prior experience with WITICSD. None of the participants had ever played WITICSD or any of the other Carmen San Diego games. Seven participants failed to show up for their appointment, resulting in 45 participants who contributed data to the study.

Materials

Materials for the study included a Macintosh® SE computer, WITICSD software and documentation, Microsoft Word™ software, custom-designed modeling presentation software, written instructions, a pad of paper, and a pen.

WITICSD is an educational software game. In the game, the player takes on the role of a detective solving a crime. Solving the crime entails interacting with the software to obtain clues, tracking the criminal through time and space, acquiring an arrest warrant, and arresting the criminal. Players decipher clues about the identity of the criminal and the destination he or she is traveling to by using the New American Desktop Encyclopedia, which comes with the software. We also provided the standard documentation for WITICSD, which includes the encyclopedia, instructions on how to use the software and hints for playing the game.

In order for participants to write their articulations, we used Microsoft Word software for word processing. Thus, participants wrote their articulations using the computer.

The custom-designed modeling presentation software consisted of MediaTracks™-produced "movies." MediaTracks enables one to record actions seen on the computer screen. After one records the movie, one can edit and add sound to the movie. The result is an animated, narrated presentation. We produced one movie for presenting the study's instructions to the participant, one movie for the expert treatment, and one movie for the novice treatment.

The instruction movie was 3:17 (minutes:seconds) in length. The content of the movie entailed screens of text that illustrated the narration of instructions for the study (see Appendix A). We also provided a print version of the instructions to the participants.

The expert movie was 7:16 in length. The content of the movie entailed an expert playing WITICSD, showing the perfect solution for playing the game. The expert's narration consisted of noting the strategies and heuristics he used while playing the game (see Appendix B).

The novice movie was 10:54 in length. On the basis of observations of novices playing WITICSD, we identified the most common mistakes novices make. The content of the movie was a novice playing WITICSD. An expert narrated as the novice performed. The narrator noted the successful and unsuccessful strategies the novice was using (see Appendix C).

It is important that we make clear the distinction between the expert and novice movies. The expert movie emphasized a perfect path solution to the task and illustrated advanced techniques for solving the problem whereas the novice movie illustrated errors and their outcomes and solutions in the course of playing the game.

Additional materials for the study included a blank pad of legal paper and a pen.

Procedure

Pre-Treatment Activities. Participants signed up for individual, one hour time slots over a one month period in the late fall. To confirm their appointments, we contacted each participant by phone or E-mail. We told participants that they would be user-testing some educational software.

We conducted the study in the conference room of a university building. The computer was on the conference room table. The blank legal pad and the pen were to the left of the computer, and the instructions, program documentation and encyclopedia were to the right of the computer. The experimenter sat to the back and right of the participant in order to observe all of the participant's actions.

When the participant arrived at the testing site, the experimenter explained the nature of the experiment to the participant as well as issues of confidentiality and voluntary participation. In order to decrease anxiety, the performance of the software, not the participant, was emphasized. The experimenter told participants that they would be testing some educational software and that our interest was in the software's performance, not theirs.

Next, the experimenter pointed out the resources the participant had at his or her disposal throughout the study. The experimenter showed the participant the documentation, instructions, encyclopedia, notepad and pen.

The experimenter then played the instruction movie for the participant. Prior to playing the movie, the experimenter reminded participants that they had a printed copy of the written instructions that they could use at any time during the experiment or to follow along during the movie.

Since the focus of this study was on problem solving strategies and not procedural knowledge of using the software and hardware, we wanted to make sure all participants were comfortable in the procedural aspects of the Macintosh and WITICSD before receiving treatment. After the participant had viewed the instruction movie, the experimenter would explain the basic use of the computer and the mouse pointing device. This required that the participant demonstrated proficiency in using the mouse to interact with the computer. We always observed accomplishment of this exercise.

In order to make the participant familiar with WITICSD user interface, the experimenter conducted a practice task. In this task, the experimenter guided the participant in using the WITICSD software by exploring one location. The experimenter explained how to click the various buttons, obtain clues, and travel from one location to another while the participant clicked the appropriate buttons. The experimenter told the participant that this was a practice task for their familiarity only and he encouraged them not to be concerned about solving the task successfully. Participants could ask questions about the functional use of the software and hardware only during this practice task.

These orienting activities and associated practice not only helped the participants learn about how to use the software, but helped form the context for the task itself, especially the modeling.

Treatments. The experimenter randomly assigned participants to one of the three treatments, expert, novice and control. For the expert and novice treatments, the experimenter prefaced the showing of the appropriate movie with the statement that the participant will now see a short movie that will give the participant more information about playing WITICSD. The experimenter encouraged the participant to do nothing else but watch the movie. The control treatment group did not watch any movie.

Articulation Task. Upon completion of the treatment, the experimenter opened the word processing software and instructed the participant to answer the question, "Explain to a friend how to play Where In Time Is Carmen San Diego." Each participant had five minutes to answer the question. When the participant finished his or her answer, the experimenter saved the answer in a file named after the participant.

Game Task. At this point, the participant played a single game of WITICSD. The experimenter set up the software so that all participants played the same game, the stolen Sultan's Howdah. In order to avoid participants who, lacking motivation to work efficiently, simply randomly pressed buttons to finish the experiment quickly, we offered a $10.00 prize to the participant who completed the game with the most remaining chronotime (a measure of efficiency used in the game).

Dependent Measures. During the task, the experimenter recorded data using a data tabulation instrument (See Appendix D). The experimenter recorded data for each location the participant visited.

- Location/Date. The location and date the participant navigated to while playing WITICSD. For example, France, 1892.
- WITICSD Chronotime. The chronotime displayed on the game screen was recorded when the participant first entered a new location. When the participant made a successful arrest, the ending chronotime was also recorded. Unsuccessful arrests resulted in a chronotime of 0 being recorded.
- Actual chronological time. Time was recorded to the second at the beginning and conclusion at each location and for the entire game.
- Witness. One point (or hash mark) was recorded each time the participant went to the witness for clues. If the participant had the

option to obtain more information while viewing the witness, an additional mark of "m" indicated that the participant viewed that "more" information, and a mark of "o" indicated that the participant did not view more information. If no "more" option was available, a dash (-) was recorded beside the hash mark in the witness box.

- Informant. One point was recorded each time the participant went to the informant for clues. If the participant had the option to obtain more information while viewing the informant, an additional mark of "m" indicated that the participant viewed more information, and a mark of "o" indicated that the participant did not view more information. If no "more" option was available, a dash (-) was recorded beside the hash mark in the informant box.
- Scanner. One point was recorded each time the participant went to the scanner for clues. An option to scan further was come across randomly after an initial scan was completed. An "f" was recorded beside the scan hash mark if the scan further option was taken.
- Note Taking. One point was recorded each time the participant wrote a note. For example, if the participant wrote a note, the performed another recordable activity, such as using the encyclopedia, then wrote another note, two points would be recorded. On the other hand, if the participant wrote a note, thought for a while, then wrote another note, only one point would be recorded since the participant did not perform a recordable activity between note writing.
- Reference. One point was recorded each time the participant used the New American Desktop Encyclopedia to look up information. For example, if the participant used the encyclopedia, then performed another recordable activity, such as taking a note, then referred back to

the encyclopedia, two points would be recorded for this measure. On the other hand, if the participant used the encyclopedia, thought for a while, then used the encyclopedia again, only one point would be recorded since the participant did not perform a recordable activity between the two instances of using the encyclopedia.

- Program Documentation. One point was recorded each time the participant used the program documentation to look up information. For example, if the participant used the program documentation, then performed another recordable activity, such as taking a note, then referred back to the program documentation, two points would be recordedfor this measure. On the other hand, if the participant used the program documentation, thought for a while, then used the program documentation again, only one point would be recorded since the participant did not perform a recordable activity between the two instances of using the program documentation.
- Select Clues. One point was recorded for each plain clue, such as sex, eye or hair color, the participant entered into the crime computer database.
- Subtle Clues. One point was recorded for each subtle clue, such as the criminal's favorite author or artist, the participant entered into the crime computer database. Randomly, the game would present hair or eye colors which required some inferential problem solving skill. For example, "she had hair the color of mahogany" is an inferred hair color clue. When such a clue was correctly recorded in the crime computer database, one point was recorded in the inferred clue box.

- Arrest Warrant Attempt. One point was recorded each time the participant attempted to get an arrest warrant by clicking the Compute button in the crime computer database.
- Arrest Warrant. One point was recorded when the participant obtained an arrest warrant.
- Task Complete. One point was recorded when the participant completed the task by arresting the suspected thief. This means that if the participant falsely arrested a thief, the task was recorded as complete even though it was not successfully completed.
- False Arrest. One point was recorded if the participant falsely arrested a suspect, by either not having an arrest warrant or having an arrest warrant for the wrong criminal.
- False Leads. One point was recorded if the participant followed the suspect to an incorrect destination.

Success in completing the task, which we call outcome, was operationalized in the following manner. We scored participants who acquired the correct arrest warrant, successfully tracked the thief, and made the arrest as 3. Participants who acquired the correct arrest warrant **or** tracked the thief and made the arrest were 2. Participants who **neither** obtained the correct arrest warrant nor tracked the thief and made the arrest were 1.

We determined the effectiveness in completing the task by scoring and combining the four key task strategies, witness, informant, scanner, and notes, into one measure, called effectiveness. We judged a participant to be effective in their use of key strategies if they don't use the witness and informant more than once for each location, don't use the scanner at all, and take at least one note at each location.

Scoring each of these strategies was in the following manner. If the participant accessed the witness clue one or fewer times per location, we awarded one point. Accessing the witness clue two or more times resulted in no points. We totaled the points, then divided by the total number of locations visited by the participant, resulting in a score between 0 and 1. We used the same methodology to calculate the score for the informant. Scoring for the scanner was similar to the witness and informant, however not using the scanner resulted in one point per location, while using the scanner at a location resulted in no points. Scoring notes was also similar to the witness and scanner, with one point awarded per location if there was at least one note, and no points awarded if there were no notes. We calculated a mean score for the effectiveness of the key strategies by adding the scores for witness, informant, scanner, and notes, then dividing by four.

Two raters judged the articulations. They classified the articulations into four equal sets of bad, good, better and best articulations. We then combined these articulations into two equal sets, with the bad and good sets classified as weak articulations, and the better and best sets as strong articulations This rating resulted in an inter-rater reliability of .75. Differences were discussed and resolved by the two raters.

Debrief. At the conclusion of the experiment, the experimenter explained to the participant the actual purpose of the study. In addition, the experimenter was able to ask the participant several informal qualitative questions about his or her performance. We wrote the responses to these questions on the participant's data sheet. Participants were also able to ask the experimenter questions about the study. We concluded the study by thanking the participant for their help and assuring them they would receive extra credit for their class.

Results and Discussion

Hypotheses One and Two

Our first hypothesis predicted that both the novice and expert modeling would result in better task performance than the control. We determined task performance through two measures, outcome and chronotime. Participants who obtained an arrest warrant and tracked the thief successfully received credit the remaining chronotime WITICSD. This number ranged from 1 to 21, whereby the higher the number, the more successful we judged the participant. All other participants received 0 chronotime illustrating their failure in successfully completing the game.

We used a one-factor ANOVA to analyze these variables. There was no significant difference between the modeling and control treatments for both the outcome and chronotime variables. Thus, there was no support for hypothesis one. This finding contradicts the findings of many of the modeling studies referenced in this paper, whereby modeling increased a participant's task performance.

There are a number of possible explanations for why we did not observe significant differences between the expert, novice and control treatments. First, the expert and novice modeling may have contributed to a false sense of expertise among participants. That is, by watching the modeling movie, participants became overconfident in their ability to play the game. To further support this explanation, data from the debriefing shows that six participants mentioned that the modeling movie contributed to them ignoring the program documentation. As one participant said, "I forgot about the instructions after watching the movie."

A second explanation suggests an opposite phenomena for the control. Instead of having a false sense of expertise and being overconfident in their ability to solve the task, the control group struggled with the problem. Thus, they may have had to use a greater set of problem solving heuristics and learn more from their trial and error. Although the finding was not significant, the control took longer (M=1121 seconds) to complete the task than either the expert (M=795 seconds) or the novice (M=854 seconds). This may indicate that the control was thinking more about the task than either the expert or novice.

A third explanation is the nature of the task, a computer game. While none of the participants had ever played WITICSD, a number of participants indicated that they had played other computer or video games before. Thus, the successful performance of the control group may be due to the skills and strategies participants developed while playing other computer games.

A fourth explanation is orienting activities. Perhaps the orientation and instructions given to each participant revealed too much game strategy, especially for the control group.

We found no support for our second hypothesis either. Our second hypothesis predicted that novice modeling would result in better task performance than expert modeling. For this analysis, we used the same outcome and chronotime dependent variables as in hypothesis one. A one-factor ANOVA analyzed the variables. There was no significant difference between novice and expert modeling.

The lack of difference between the novice and expert modeling may be caused by the novice group not observing successful task completion. We anticipated that the novice modeling would result in stronger performance since the participants would learn to avoid the common mistakes novices tend to make. However, the novice in the novice modeling movie did not successfully complete the task, whereas the expert in the expert modeling movie did. Thus, participants in the novice group may not have had a clear idea of how to recognize successful task performance.

Hypotheses Three and Four

Hypothesis three predicted that expert and novice modeling would result in better use of key task strategies than the control, and hypothesis four predicted novice modeling would result better use of key task strategies than expert modeling. As defined above, we created a dependent measure called effectiveness by scoring the participant's use of witness, informant, scanner, and note taking. Thus, we compared expert and novice modeling to the control by examining the effectiveness. A one-factor ANOVA analyzed the variables.

A significant difference (Df 2:42, F=6.32, p<.01) was found between the expert (M=.809), novice (M=.841) and control (M=.693) treatments. Additionally, a Fisher PLSD test revealed that novice was significantly different from control (.088, p<.05) and that expert was significantly different from control (.091, p<.05). Thus, hypothesis three has support. While hypothesis four appears supported, with novice modeling having a slightly higher mean than the expert modeling, a follow-up Fisher PLSD test between expert and novice yielded no significance.

Although we found no significance with hypothesis one and two, the significance found in hypothesis three identifies a key effect of the expert and novice modeling. From the results, we can infer that participants who viewed a model learned to use the key task strategies better than the control. Additionally, there is slight evidence that the novice group learned to use the key task strategies better than the expert group.

One would expect that if participants used the key task strategies effectively, they would successfully complete the game. However, the data show an incongruence between hypothesis one and three, and hypothesis two and four. It is possible to explain this incongruence because while participants in the expert and novice modeling treatment groups may have used key strategies more effectively than the control group, we have no direct way of knowing how they interpreted the information gained from exercising those strategies. Interpretation can only be inferred by a participant's successful completion of the game. If a participant successfully completed the game, then we can infer that they were successful in interpreting the clues. The key task strategies are only a means of uncovering clues necessary for successful completion. Thus, they have only a partial role in predicting successful completion.

Hypotheses Six through Eight

Our fifth hypothesis predicted that novice and expert modeling would result in stronger articulations than the control. We used a one-factor ANOVA to analyze the variables. We found no significant difference, indicating that neither novice nor expert modeling resulted in stronger articulations by the participant. Hypothesis five had no support.

Hypothesis six predicted that novice modeling would result in stronger articulations than expert modeling. A one-factor ANOVA analyzed the variables. There was no significant difference, thus the novice model did not cause stronger articulations than the expert model. We did not support hypothesis six.

Our seventh hypothesis was similar to the third hypothesis except we predicted that participants with strong articulations would use key task strategies more effectively than those with weak articulations. Independent raters scored the quality of articulations as either good or bad. Thus, we compared the good and bad articulations with effectiveness using a one-factor ANOVA. There was no significant difference, indicating that the quality of articulations did not affect the use of key strategies. Hypothesis seven had no support.

The explanation of why there was no difference for this hypothesis is similar to the explanations presented for hypotheses one and two. It is possible that the novice and expert modeling caused a false sense of expertise in participants, resulting in weak articulations for some. Additionally, the orientation activities may have provided too much information about how to play the game.

Hypothesis eight predicted that strong articulations would result in better task performance than weak articulations. For this analysis, we used the outcome and chronotime dependent variables used in hypothesis one and two as a measure of task performance. We also used the same articulation ratings found in hypothesis six and seven. A one-factor ANOVA analyzed the variables.

The results of this analysis were significant for both outcome (Df 1:43, F=4.648, p<.01) and chronotime (Df 1:43, F=10.078, p<.01). A Fisher PLSD test (.449, p<.05) revealed that participants with articulations classified as "good" had a mean outcome score of 2.435 while "bad" articulations had a mean outcome score of 1.727. A Fisher PLSD test for chronotime (3.908, p<.05) showed that the mean chronotime for "good" articulation was 6.087 while mean chronotime for "bad" articulation was 1.909. On the basis of these results, there was support for hypothesis eight -- strong articulations contribute to successful task performance.

This finding shows the importance of designing instructional interventions that contribute to forming strong articulations, since strong articulations are a good predictor of success. We should consider designing instructional interventions with the goal of enabling the learner to form strong articulations. This strategy contradicts the traditional concern for the terminal goal -- successful performance on a task. Facilitating successful performance was our paradigm when we designed the expert and novice modeling movies. An articulation-focused design strategy changes our paradigm to where we are more concerned with enabling learners to talk about how they solve problems rather than strictly focusing on enabling them to complete the task successfully.

Summary and Conclusion

The results of this study offer a number of interesting findings. We were unable to replicate the results found in previous modeling studies in which modeling enabled participants to perform better on a task. We also found no difference between the novice and expert groups in terms of task performance. However, we did find that novice and expert groups used key task strategies more effectively than the control group, and that there may have been only a slight difference between the novice and expert groups.

Our articulation task yielded similar results. We found no differences for the expert, novice and control treatments on the quality of the articulations. Additionally, participants with good articulations did not use key task strategies any differently from participants with bad articulations. However, participants with good articulations performed better on the task than participants with bad articulations.

Why didn't our findings support our many of our key hypotheses? We believe the main reason is the effect of the orienting activities. In order to make sure participants were technically able to use WITICSD, we conducted an extensive set of orienting activities common to all treatment groups. While we accomplished our goal of enabling participants to be technically competent, we may have told them too much. This might account for the lack of difference in task performance and articulation quality between all treatment groups.

There are two key implications from our study. First, cognitive modeling, regardless of the verbalization technique used, aids learners in adopting key task strategies. Thus, one should adopt cognitive modeling as an instructional strategy if the instructional objectives require the learning of heuristics. Second, since the quality of articulation is a predictor of task performance, we should design instruction to achieve quality articulations. Learners who can explain how they will solve a problem will experience more successful task performance.

Future research in the area of cognitive modeling should continue to explore variations in verbalization and their effects. Researchers should take time to consider the orienting activities, especially when working in a computer-based training environment. Additional research should discover how to facilitate quality articulations in instructional programs.

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Appendix A - Instructions Transcript

You will be playing a computer game called Where In Time Is Carmen San Diego. The object of the game is to catch a thief who has stolen a historical treasure.

In order to catch the thief, you must do three things:

1) You must gather clues to determine the thief's identify and to follow the thief's trail. Clues are gathered by using the search button, followed by either the Witness, Informant or Scanner buttons. The Witness and Informant buttons may contain clues about the thief's identity and his or her next destination. The Scanner button contains clues only about the thief's next destination.
2) You must follow the thief's trail from country to country. The Travel button enables you to travel to the next destination. Use the clues you've gathered to determine the next destination.
3) You must obtain an arrest warrant before arresting the thief. Arrest warrants can be obtained through the Data, then Evidence buttons. Record the clues you've gathered and use the Compute button to determine if the clues match a criminal and enable you to obtain an arrest warrant.

Here are some hints for playing the game:

1) It's a good idea to keep notes on paper as you gather clues.
2) Remember to work quickly and efficiently - you only have a certain amount of time to complete the task. Time is subtracted only when you a) travel from one location to another (here the time used is approximately 3-5 hours), b) obtain clues from the witness, informant or crime scene scan (here the time used is approximately 1 to 2 hours), or c) compute the evidence to try and obtain an arrest warrant (here the time used is 1-2 hours). No time is counted against you when you look up information from the reference sources.
3) You'll know when you have tracked the thief successfully when you see suspicious persons. The suspect you're tracking uses other gang members to check you out when your are getting close. If you interrogate a witness, informant or crime scene and they know nothing, you're probably in the wrong location. You'll then have to backtrack to the previous location to get back on the trail of the criminal.
4) When the criminal is at the same location your are, he or she launches a sneak attack against you. Make sure you have your warrant when this happens or else the criminal will get away. If you have your warrant, look to other sources of clues to find the criminal.
5) The key to tracking the criminal is deciphering the clues you find. You can decipher clues with the New American Desk Encyclopedia. Be sure to look at the "How To Use" section in the Encyclopedia.

Here's an example of how to acquire clues and evidence:

For example, let's say you use the Witness button and the clue is, "She wanted to talk with Dag Hammarskjold about economy." You could then look up "Hammarskjold" in the encyclopedia and find out he was a Swedish stateman in the 1900's. This clue would tell you the criminal's next destination is probably Sweden in the 1900's.

In addition to this clue, there is another button called More. You can click this button to get evidence about the criminals identity. For example, if the clue is "She just finished reading the book 'Animal Farm'.", you would go to the evidence selector by clicking the data button. You would then select each author, and look up in the encyclopedia if that author wrote 'Animal Farm'. So in this case, we would find George Orwell and keep him selected as a piece of evidence.

Appendix B - Transcription of Expert Movie

This movie is a demonstration on how to play Where in Time is Carmen San Diego. My name is Peter and I'll be showing you how to play the game. In this case the Indian Constitution has been stolen from India in 1947 by an unknown male. I have written down these facts in my notebook. The Federal Time Commission has given us 33 hours to solve the crime. We'll begin our investigation by searching for clues at the scene of the crime. I'll first investigate the witness. Here I find that the thief wanted to join a group called the Samurai. This gives me some information as to the next destination of the thief. Samurai, if I look 'em up in the Desktop Encyclopedia, are from Japan during the years 1000-1600 A.D. I'll write this down in my notepad for future reference. The 'More' button gives you clues as to the identity of the thief. Here (the more button) I get the clue that the thief had hazel eyes, and I'll write that down on my notepad as well. When I uncover data about the thief's identity I'll want to record them in my evidence folder. I look back in my notes and I see that one of the clues is that the thief is a male. I'll enter male under the sex option. I also know that the thief's eyes are hazel, so I'll click the eyes button until hazel appears. I won't compute yet to get an arrest warrant because I don't have enough information and it would just waste valuable Chronotime. so I'll continue my search.

The next place I'll investigate is the informant. Here I learn the thief wanted to spy on the Anu tribe. Once again this clue will give me some idea as to the location the thief went to next. And if I look up the Anu tribe in the Desktop Encyclopedia, I'll find that the Anu tribe was part of Japan as well, so I can deduce from my Samurai clue and this clue that the next destination of the thief is Japan. When I click the 'Travel' button, I'll see that Japan is one of the destinations, and that's where I'll follow the thief to next. Notice that I did not go to the 'Scanner' for any clues. This would be a waste of Chronotime since the 'Scanner' only gives me clues as to the thief's next destination, and I was already able to deduce the thief's next destination based on the two clues I received previously.

As in the previous location, I'll start my search by going to the Witness. O.K., a V.I.L.E. henchman has been detected. This is feedback the game gives me to tell me I have correctly followed the thief to the next destination. If I hadn't followed the thief to the next destination, the witness would have said to me, he had never heard of that person, or doesn't know anything about what I'm talking about. The witness tells me that the thief wanted to go to Lima, so I write this down on my notepad, and I look up Lima in my Desktop Encyclopedia, and find out that Lima is the Capital of Peru. This gives me a pretty good idea that the next destination of the thief is Peru.

I'll click the 'More' button to find out another clue as to the thief's identity. Here I find that the thief was holding a copy of The ^Hunchback of Notre Dame. This gives me some idea as to the author the thief liked. I'll immediately record this clue on my notepad as well as in my evidence folder. I'll click the 'Author' button and the first author that appears is Doysteyevski. I'll look up Doysteyevski in the Desktop Encyclopedia and see if he had anything to do with a book about the Hunchback of Notre Dame. He doesn't, so Ill have to go on to the next author. The next author is Victor Hugo. I look him up in the Desktop Encyclopedia and sure enough he is the author of The Hunchback of Notre Dame. Since I have three clues, this is usually enough to compute an arrest warrant, and sure enough the clues match a particular suspect.

Now that I have an arrest warrant for the thief, I have to track him as quick as possible to the next destination. From the clue the witness gave me, I know his next destination is probably Peru. So I don t need any more clues, and I'll travel directly to that location. Once again, I'll begin by searching for clues...ahh, I've found another V.I.L.E. henchman this means I still must be on the right track of the thief. The clue the witness gives me is that the thief wanted to meet the founder of the Capetians. I write Capetians down in my notepad, and look it up in my Desktop Encyclopedia. The Capetians are from France, so I can be pretty sure that the next destination of the thief is France. Since I'm pretty sure of that clue, I won't waste valuable time searching for other clues; I'll go directly to the thief's next destination.

I'll start once again by searching for clues at the witness. It looks like the thief is trying to kill me. This means he must be at one of the other sources of information at this destination. It also means that if I don't have my arrest warrant, I'd better go get it. Otherwise, I'll be charged with a false arrest. But since I have my arrest warrant, I can go searching for the thief to try and catch him. Let's try the scanner to see if that will locate the thief. There he is, now the capture robot will go do the work. Good, we've captured the thief. We'll now send the data to the crime computer to verify his identity, and we'll get a congratulatory message from the Chief. That's how you play the game Where in Time is Carmen San Diego. Remember to record notes of clues you uncover during your search, and to use the Desktop Encyclopedia to interpret those clues and determine the next destination or identity of the thief. Also remember to get an arrest warrant before capturing the thief. now be given a chance to play the game yourself. Good luck.

Appendix C - Transcription of Novice Movie

"In this demonstration we'll be watching a first-time player play the game Where in Time is Carmen San Diego? My name is Peter and I'll be commenting on the player's performance as we watch the game. In this case an unknown male has stolen the Indian Constitution from India in 1947. The player has proceeded to the scene of the crime, and has thirty-three hours in which to solve the case. Let's watch as the player begins her investigation.

Here we see the player searching for clues at the witness. This particular clue about a gang of Samurai gives the player a tip about where the thief went to next. However, the player does not write down the clue or does not look at the Desktop Encyclopedia in order to decipher the clue. While the player was at the witness, she missed clicking on the 'More' button. The 'More' button would have given her a clue as to the identity of the thief. This would have helped her to get an arrest warrant. But now we see that she wants to go travel somewhere.

Without deciphering the clues the player received at the witness, regarding the Samurai gang, she has travelled randomly to the United States. Let's see what happens now. As we can see the witness has nothing the tell the player. This means the player has travelled to the wrong location. What she needs to do now is get back to her previous location and get back on this trail of the thief. The player has now returned to India in the 1900's, therefore she is back on the trail of the thief. Notice the Chronotime is at 27 hours. Each time the player travels to a destination, or obtains a clue from the witness, informant, or scanner, time is counted off the total chronotime. This means you have to be sure of where you're travelling, or to be efficient in searching for your clues so you do not run out of chronotime. Running out of chronotime means you will not be able to catch the thief. Let's watch now as she continues her search .

Here the player gets the clue of the Shinto Shrine. She writes it down on her notepad and looks up 'Shinto' in her Desktop Encyclopedia. Once again the player forgets to click the 'More' button under the witness to get a clue as to the identity of the thief.

In the informant, the player finds the clue of the Golden Hall of Haruji. She writes these words down in her notepad, and looks up both Golden Hall and Haruji in the Desktop Encyclopedia. She finds nothing for these terms. Based on the clues she received from the witness and the informant, the player seems to have deduced that the next destination of the thief is Japan. What we have just witnessed is the appearance of a V.I.L.E. henchman. These V.I.L.E. henchmen check up on you when you are following the thief correctly. Thus, the player has correctly followed the thief to Japan. In the informant the player gets the clue of Austin & Emma. This clue gives the player some idea of where the thief travelled to next. She writes the clue down on her notepad, and looks up Austin in the Desk Encyclopedia. Once again the player missed clicking on the 'More' button to get a clue as to the identity of the thief. In the witness, the player gets the clue of Rugby. She writes Rugby down on her notepad and looks up Rugby in the Desk Encyclopedia, however, cannot find an entry for it. Once again, the player has not clicked on the 'More' button in order to get a clue as to the identity the thief. Without these types of clues, the player will not be able get an arrest warrant, thus, the player will not be able to win the game. It's very important that, when you do not have an arrest warrant, you always click the 'More' button to get some idea of who the thief is.

It seems that from the clues of Austin & Emma and of Rugby the player was able to deduce that the next location that the thief travelled to was England. Let's see if that turns out to be correct. ^once again the V.I.L.E. henchman has appeared, so the player has successfully tracked the thief to the next destination. Here (under button which has just been pushed and illustrated on the screen) the player receives the clue of a mousetrap. She writes it down on her notepad and looks it up in the Desk Encyclopedia, but finds nothing. I tend to ^feel that the scanner is a waste of time, most of the clues that you need to ^follow the thief can be found in the witness and informant. Plus, the scanner will never have a clue as to the identity of the thief. I usually only the use the scanner as a last resort if I cannot figure out the destination of the thief from the clues I obtain in the witness and informant. In the witness the player gets the clue Titanic. She writes it down on her notepad, and looks it up in the Desk Encyclopedia and finds a reference for it.

Based on the clue of the Titanic, the player has deduced that the next destination of the thief is England in the 1900's. Note that back in the witness, she did not click the 'More' button once again. This denied her of an important clue as to the identity of the thief, which would have helped her get an arrest warrant. When a life- threatening trap has been set against the player, as the one that we just saw, this means that the thief is somewhere at this destination and that the player has to try to find the thief's whereabouts at either the witness, informant or scanner. It appears that the player has finally realized that she needs an arrest warrant to catch the thief. Since the player did not investigate any of the 'More' buttons to obtain clues as to the identity of the thief, the only clue she has is that the thief is a male. Usually~ you need three or more clues in order to obtain an arrest warrant. So I do not think this player will be getting an arrest warrant this time. As I mentioned, only one clue is insufficient data, and returns a whole list of possible suspects. Thus an arrest warrant cannot be issued.

Another trap has been uncovered, the player is now getting close to capturing the thief. The player has located the thief, and now the capture robot will be sent to make the arrest. Well, the player has successfully tracked Russ T. Hinge but unfortunately, without an arrest warrant, Russ T. Hinge is allowed to go free. Although the player made a minor mistake at the beginning of the game, she was able to successfully track the thief from destination ~. destination. However, she did forget to acquire clues as to the identity of the thief which prevented her from getting an arrest warrant. You'll now be able to have a chance to play the game Where in Time is Carmen San Diego. Good luck.

Appendix D - Data Collection Instrument

Subject:
Treatment:
Coach Name:
Observer Name:

Start Time:

End Time:

Task #2

Destinations	1	2	3	4	5	6	7	8	9	10
Location/date										
Chronotime										
Witness										
Informant										
Scanner										
Note taking										
Reference										
Program doc.										
Select clues										
Select Inferred clues										
Arrest warrant attempt										
Arrest warrant?										
Task complete.										
False arrest										
False leads										

Title:

Different Computer Graphics for Girls and Boys? Preliminary Design Guidelines

Authors:

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Abstract

Girls and boys may like different kinds of computer graphics. A gender gap favoring boys has been reported in computer usage. Graphics may play a role in bridging that gap because of their motivational value. We give an overview of gender differences reported in the literature regarding graphic content, color, detail, size, and movement. Based on our findings, we propose preliminary design guidelines for graphics in computer-based instructional materials to increase attention and invoke interest of both genders. Cross-cultural and age differences need to be examined and the validity of the preliminary guidelines tested to develop operational guidelines.

In recent years, authors (e.g., Krendl, Broihier, & Fleetwood, 1989; Sutton, 1991) have documented evidence of a gender gap in computer usage. Krendl et al. (1989) reported that various explanations were offered, but most authors agreed the consequences of this gap would increase occupational and economic inequalities between men and women . In a three year longitudinal study they found a strong tendency among boys to respond favorably to computer-based instruction and pursue out-of-school computer activities. In contrast, the girls tended to appear intimidated by the technology and not pursue out-of-school computer activities.

Illustrations play a major role in motivating readers to pick up, browse through, and read books (Duchastel, 1978). Dwyer (1988) reported that visualization in the instructional process increased learner interest, motivation, curiosity, and concentration. Graphics then, may play a similar role in computer-based instruction. Just a little over a decade ago graphics in instructional computer software were restricted by hardware to low resolution (block), monochrome images. Since then rapid advances in the technological capabilities of desktop computers have hurled software developers through numerous advances in screen resolution, color palettes, image processing speed, available memory, and production tools. These advances have resulted in instructional software that often has a heavy visual element. However, little notice has been given to critical issues in the design of computer graphics such as gender differences in children's creation and preferences for graphics and illustrations.

The following review of the literature suggests that boys and girls differ in their creation and preference of certain graphic elements. Freedman (1989) observed that changes in fifth grade girls' images were often subtle, they seemed more concerned than boys with the use of color, whether colors went together, and often discussed relational size and arrangement of shapes . The boys were more concerned with movement and sometimes conceptualized shapes as objects capable of violence.

Jones (1987) found that preschool girls' designs contained greater variety and detail than those of boys, and that girls significantly verbalized more than boys when referring to color selections.

In another study with preschoolers (Calvert, 1989), where computer objects such as animals and vehicles were randomly assigned sounds and actions (animation), boys chose more often action objects than non-action objects while the girls did not.

The computer program Storybook Weaver: World-of-Make-Belief (MECC, 1991), allows users to create stories and illustrate them with professionally prepared art images. The designer of that program, (J. Sharp, personal communication, March 10, 1992), had observed gender differences in stories and graphics children created with the program. She described girls' art as being "friendlier" than boys art, using for example animals and nature images, brighter colors, and daytime scenes. The boys' art was "scarier," night scenes were popular, often with pairs of eyes lurking in the background. Goblins, and sea mammals were prominent among the creatures boys chose to use in their pictures, and clouds, storm, lightning, and fire among other art pieces more characteristic of boys' graphic creations than girls'.

Other studies and observations, although not examining computer graphics, support these findings, revealing considerable gender differences regarding content, color, detail, size, and movement of objects. A description of them follows.

Content

Striking differences have been found in the content of graphics created by elementary school children (Feinburg, 1977; McNiff, 1982). In McNiff's analysis of over 1800 drawings by 26 children, the girls' art was described as quiet and socially-oriented with more people, plants, and animals with the exception of sea animals. The boys' art was more "active" than girls' art and object-oriented with machines, such as cars and motorcycle in chases and races, and conflicts, for example struggles and battles.

Regarding the subjects of conflict and help, Feinburg (1977) found large differences. Conflict for the girls was seen as interpersonal conflict, usually with two friends or relatives in direct confrontation. On the other hand, boys drew structured situations, involving teams, and armies. Portraying helping, personal assistance was dominant for both girls and boys. However, girls' responses were more closely related to family and friends while boys often included rescue and danger.

Gender differences regarding content are not only reflected in graphics but also in written materials. Trepanier-Street and Romatowski (1991) analyzed for example stories by 180 children in grades 1 to 4. They found that characters in stories by girls showed more often pro-social behavior than characters in boys' stories. The opposite was true regarding aggressive behavior. Also, emotional statements were more common in the girls' stories than the boys stories while high risk/adventure themes were more common in boys' stories as well as assignment of high intensity actions to the characters, and a higher percentage of male characters than the girls had in theirs. Similarly, Libby & Aries (1989) analyzed fantasy narratives by 42 preschoolers. They found that girls introduced significantly more female characters and friendly figures who offered assistance while boys introduced significantly more male characters, aggressive behavior and attempts to master situations through the use of aggressive activity. In another recent study by Haynes and Richgels (1992), children in grade four indicated their preference for fictitious annotated book titles. Girls' highest ranked factors included fantasy items and items about growing up and among their other top choices were two historical nonfictions, a social studies item about people in the U.S., and a science item about weather, plants, experiments, and animals. Boys' highest ranked factors included items about adventure, space, science and sports and among other top choices were items about mystery, suspense, and realistic animal fiction. Items that appeared high on the list for both genders were traditional and modern fantasy, realistic fiction, romance, and adjustment, historical fiction, scientific items and biographies.

Findings regarding content imply that peaceful looking graphics with people, plants, and animals tend to be of high appeal to girls, while graphics with figures in actions, vehicles, and implied conflict, danger or suspense tend to be of high appeal to boys.

Color

A color preference study (Child, Hansen, & Hornbeck, 1968), with more than 1,100 students in grades 1 to 12, found that girls consistently preferred lighter colors than the boys did when looking at 35 pairs of colored squares. An exception was the color red. However, Guilford and Smith (1959) did not find a difference in preference for lighter colors. They tested over 200 colors in their study with 40 young adults. However, women in the study gave overall lower ratings for colors than men did.

Results from studies regarding color preferences are not very generalizable. The colors used vary from study to study and the total number of possible colors is huge with differences in the three perceptual dimensions of color: hue; lightness or value; and saturation. Also, numerous other factors affect people's preferences, such as the conditions in the study, current fashion, cultural differences, difference in color perception, and the type of colored materials used. A blue color that most people may find nice on a small "objective" square may not be the first preference for a whole room, or look appetizing in a pasta dish.

Other studies involving color, have found that females have more words to describe colors than males (Lynch & Strauss-Noll, 1987), and female-interest pictures elicited significantly more color reference from both women and men than male-interest and neutral-interest pictures (Crawford & Chaffin, 1987).

Based on these findings it seems that girls may be more interested in colors than boys; but possibly more critical of colors, and whether they go together. Girls may also prefer lighter colors than boys do.

Detail and Size of Objects

Goodenough (1926) developed a popular method to measure children's intellectual maturity. She analyzed and compared drawings of a man by several thousand children of different ages. She found that girls drew more items and with more detail than the boys.

Another finding showed that female college and high school students remembered more detail on photographs in a recall condition than males, especially relating to persons (McGuinness & McLaughlin, 1982).

It seems obvious that details in drawings must be tied closely to content, with increasing detail appearing for subject matters the drawer knows well or has a high interest for. For example, a study done with 6 to 11 year olds found that boys' recall-maps of their home area were richer in detail and more accurate than those of girls of a similar age (Matthews, 1986).

Size is also a variable that may be closely related to content. One study found that girls drew people bigger than do boys (Falchikov, 1990). This may reflect social-orientation and the importance girls seem to place on people in their drawings.

Based on these findings, detail and possibly size of graphic objects of high interest may be appreciated by both genders. At least, this seems to apply to detail and size of people and people-related items of high interest to females.

Movement and Dimension

Consistent gender-differences favoring males have been found in performance on spatial tasks in many studies, summarized for example by Harris (1981).

Goodenough (1926) found that two characteristics of boys' drawings were better sense of proportions than girls, and the inclusion of figures represented in profile as walking or running. The drawings analyzed by McNiff (1982) also showed there was more "action" in boys' art.

Judging from these findings and observations and results reported earlier (Freedman, 1989; Calvert, 1989), we expect items that can be moved, are animated, or at least have implied action associated with them on a still image, to be of high appeal to boys. Three-dimensional looking graphics may also be more appreciated by boys than girls.

Some Preliminary Guidelines for Computer Graphic Design

The findings from our review indicate that creating graphics that appeal to girls, designers should consider:

1. Including pictures of people, plants, and animals. (Based on: Haynes & Richgels, 1992; McNiff, 1982.)
2. Making pictures of people, plants and animals relatively large and detailed. (Based on: Falchikov, 1990; Goodenough, 1926; Jones, 1987; McGuinness & McLaughlin, 1982.)
3. Including a variety of colors, not just primary ones, possibly in lighter shades, or providing opportunity to manipulate color. (Based on: Child, Hansen, & Hornbeck, 1968; Freedman, 1989; Jones, 1987; Lynch & Strauss-Noll, 1987.)
4. Including female characters. (Based on: Libby & Aries, 1989; Trepanier-Street & Romatowski, 1991)
5. Including peaceful, "friendly" scenes. (Based on: Libby & Aries, 1989; McNiff, 1982; Sharp, personal communication, 1992).

Creating graphics that appeal to boys designers should consider:

1. Showing figures in action. (Based on: Feinburg, 1977; Goodenough, 1926; McNiff, 1982.)
2. Providing opportunity to move (or animate) objects. or implying movement of objects (Based on: Calvert, et al., 1989; Freedman, 1989.)
3. Including vehicles. (Based on: McNiff, 1982.)
4. Including male characters. (Based on: Libby & Aries, 1989; Trepanier-Street & Romatowski, 1991.)
5. Including elements of implied suspense/danger. (Based on: Feinburg, 1977; Freedman, 1989; Haynes & Richgels, 1992; McNiff, 1982; Sharp, personal communication, 1992; Trepanier-Street & Romatowski, 1991.)

More research is needed before operational guidelines can be developed. Cross-cultural and age differences need to be examined. The validity of the preliminary guidelines has to be tested. Many questions are unanswered. For example, should a graphic be developed with mixed elements of appeal for both genders, or would that result in graphics that no one liked? Should, instead, separate graphic treatments in the same instructional material be offered or different types of graphics within the same treatment? Can catering to aesthetic preferences in some cases have a negative effect on learning? However, in the past, girls may have been much less considered as an audience for computer software than boys. Using design guidelines like the ones we propose, for graphics in educational software, may help invoke attention and interest of students of both genders.

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Title:

Hints and Learner Control for Metacognitive Strategies in Problem Solving

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HINTS AND LEARNER CONTROL FOR METACOGNITIVE STRATEGIES IN PROBLEM SOLVING

This paper focuses on two types of instructional design strategies (i.e., hints and learner control) that can be used to enhance metacognitive strategies in problem solving. Hints are often referred to as cues, clues, prompts or facilitators, and learner control as student control or internal locus of instructional control. In this paper, the terms, hints and learner control are used.

Metacognition refers to the active monitoring and consequent self-regulation for which one's own cognitive mental activities become the objects of reflection (Flavell, 1987). According to Meichenbaum, Burland, Gruson and Camerson (1985), "metacognition refers to cognitions about cognitions or the executive decision-making process in which the individual must both carry out cognitive operations and oversee his/her progress" (p.5). It has a means-ends character, that aims to reflect upon, evaluate and guide cognitive activities in an effective manner (Perkins, Simmonson and Tishman, 1989).

Representative activities of metacognition include: analyzing and characterizing a problem; understanding what one needs to know; reflecting upon what one knows or does not know in order to get to the solution; making a plan for the solution; using one's cognitive resources and time on the basis of a plan made ahead; monitoring progress; evaluating the outcomes of the plan; and revising the plan (Brown, 1987; Gagne and Glaser, 1987). In learner-controlled instruction, similar learning activities are involved, by requiring learners to keep on a path of active self-regulation, and to purposefully use control options. Additionally, hints can speed and facilitate such processes of learning. Metacognitive strategies acquired through the instruction supported by hints and learner control are those that are useful for problem-solving.

In the following portion of this paper, detailed discussion on hints and learner control will be provided.

HINTS

what they are

Those who attempt to solve problems need some guidance, which can lead them to the correct solution throughout the whole process. Such guidance can be provided in a form of hints. According to Sabban (1985), hints can serve the following roles: 1) hints can stop the ongoing action or thought; 2) hints can provide a stimulant for the correct solution; 3) hints can intentionally mislead solution processes; and 4) hints can serve as a measure of success in problem solving.

why they are important

Instruction for higher-order problem-solving skills requires continuous trial and error, and the higher-order skills are compatible to learning strategy, metastrategy or metacognitive strategy (Derry and Murphy, 1986). For such instruction, hints can provide the best opportunity to initiate a new direction towards a correct solution and thus to facilitate learning when a problem solver faces trouble in progress (Sabban, 1985).

Hints can provide not only information but also stimulus for accurate problem solving by helping learners identify the major factors and underlying intention of a problem, reorganize the problem for the solution, retrieve related skills or knowledge, select appropriate strategies, and conduct problem-solving. The intent of hints is to encourage learners to work within an externally supported learning environment, in which they can conduct knowledge compilation, overcome the problem of inert knowledge and production deficiency, and develop metacognitive inner-dialogue strategies.

Hints can activate knowledge compilation processes, the translation processes of declarative knowledge to procedural knowledge. According to Gagne (1985), one of the two major types of procedural knowledge is action-sequence, which indicates the procedures to carry out sequences of symbolic operations. In developing action-sequence procedures, knowledge compilation processes are required. Gagne argues that external prompts can support the compilation processes by guiding sequential steps.

Also, hints can provide learners with cognitive support, that can compensate for the deficiency in their cognitive processing. While difficulties that learners face during problem-solving are often due to missing knowledge, in many cases those are due to inert knowledge or fragile knowledge, failing to retrieve related knowledge or to correctly combine retrieved knowledge (Perkins, Schwartz and Simmons, 1988). Especially, developmentally immature learners often exhibit production deficiencies, the failure to access and employ processing capabilities that they may actually possess (Brown, 1974). Production deficiencies may occur due to the learners' failure to recognize the usefulness of a particular set of skills in a certain learning situation as well as the desire to perform such skills.

While missing knowledge needs more review and practice to consolidate the knowledge base, inert knowledge (and production deficiency as well) requires special instructional remedy so that learners can employ knowledge and skills to work with (Perkins, Schwartz and Simmons, 1988). According to Perkins, Schwartz and Simmons, hints can be integrated into the design of instruction for the special remedy.

In addition, hints can encourage learners not only to recall and apply previously acquired learning skills but also to make such process automatic. According to Derry and Murphy (1986), the enhancement of learning abilities requires the development of not only specific learning skills but also executive control skills that automatically accesses and combines skills needed for learning. This can be applied to problem-solving abilities as well. On this point, hints can help the enhancement of executive control skills (Bonk and Reynolds, 1992). Further, according to Derry and Murphy (1986), executive control skills are those that maintain and transfer metacognitive strategies.

how to provide them

A theme emerged repeatedly in research conducted from a metacognitive perspective is that executive control skills cannot be trained directly, but must be gradually developed and automated over a long period (Derry and Murphy, 1986). Hints can be used in designing guided instruction for the training of executive control skills.

Many of metacognitive strategies related to executive control skills cannot be made explicit. Moreover, even given explicit strategies, the use of the strategies highly depends on the way in which they are embedded in instruction (Collins, Brown and Newman, 1986).

Because of these problems, Collins, Brown and Newman argue that instruction should be designed to provide learners with the opportunity to observe and engage in using an expert's strategies and related knowledge to help them understand how these strategies and knowledge fit together and cue off. On this point, they suggest the cognitive apprenticeship method which reflects modeling-coaching-fading paradigm. This paradigm is designed to help learners acquire an integrated set of metacognitive as well as cognitive strategies through observation and guided practice.

Modeling involves the demonstration of an expert's task performance, which can help learners observe and build a conceptual model of the task performance. Coaching consists of observing learners while they carry out a task and offering help as needed. Fading refers to the gradual removal of the help as learners can perform the task on their own.

In integrating hints into the design of problem-solving instruction, an expert's uses of hints can be demonstrated by prescribed instruction or by a teacher. Then, learners can have the opportunity to use the hints as they carry out a given task, while they can get help as needed. The processes of learners' performance need to be analyzed to determine when they no longer need hints. When there is an evidence of automatic initiation and use of metacognitive strategies, hints can be gradually phases out from the instruction. Through this learning process supported by hints, learners can gain control over their uses of metacognitive strategies in problem solving, and this control can become internalized.

LEARNER CONTROL

what it is

Concerning the loci of instructional control, the control can be assigned either to a program or to a learner. While program control presents instructional components on the basis of prescribed rules with little choice given to learners, learner control provides learners with opportunities to analyze their own comprehension and needs and to use instructional components according to the analyzed needs.

why it is important

Advocating learner control, Merrill (1984) conjectures an internal model of metacognition inside each learner that directs and orchestrates how s/he uses control over instructional components to enhance the present state of knowledge. On the basis of the model, a learner makes decisions and examines how the decisions work out, and through these processes, s/he can learn "how to learn".

Under learner control, learners need to be aware of control options and deliberately make decisions about the use of options. Therefore, individual learners are situated in the position to actively analyze the nature of a task, to estimate their understanding of the given task, to select activities to be performed in accomplishing the task, to decide how to perform the selected activities, and to evaluate the results of their decisions, while continuously monitoring their own cognitive processes and performances (Holmes, Robinson, and Steward, 1985; Merrill, 1984).

Through the instruction, learners can continuously practice conscious reflection on their cognitive abilities, task demands and learning strategies, and learn how to manage their own thinking processes and learning activities in order to achieve desired goals of instruction. Thus, through the exploration of given tasks and use of self-regulatory mechanism, they can be led to enhance their abilities to perform and behave strategically.

As a result, through learner controlled instruction, learners can be able to integrate new learning materials thoroughly within their existing knowledge schema, and enhance their metacognitive strategies in an effective way (Merrill, 1984; Rubincam and Olivier, 1985).

how to provide it

Significant efforts have been devoted to research on learner control, but the results have been diverse, making generalization difficult. Thus, although the question as to whether instructional designers should assign control to a learner or to a program has been frequently asked, it has not been resolved.

This may be due to the lack of instructional design supports that take off some of the cognitive burden provided by the unique learning environment and guide learners to effectively go through the instruction (Jo, 1991). On this point, recommendations made by theory and research need to be integrated into the design of instruction to help learners consciously make decisions over their own learning and build effective learning strategies.

First, control options should be clearly labeled to help learners use control options effectively (Reigeluth and Stein, 1983). Second, immediate feedback, continuous advice on learners' on-going progress and summaries of their uses of control options should be presented to help learners make "informed decisions" about their own learning (Hannafin, 1984; Kinzie, 1988; Lepper and Malone, 1987). Third, basic requirement over important instructional components should be provided to learners in order to assure that they do not bypass the components (Kinzie, 1988). Fourth, prior to instruction, pretraining should be provided to learners to help them become familiar with the novel learning system with control options, perform conscious cognitive information processing, and understand objectives, procedures and values involved in building their own learning strategies (Hannafin, 1984; Holmes et al., 1985; Kinzie, 1988; Merrill, 1984; Schmitt and Newby, 1985). Schmitt and Newby (1985) argue that if learners learn when and why they need to use such strategic approaches (conditional knowledge) along with learning what they are (declarative knowledge) and how to use them (procedural knowledge), the learners can quickly gain competence and confidence in their own abilities to use the approaches appropriately and to achieve excellent outcomes. Thus, pretraining can contribute to helping learners gain such knowledge.

The metacognitive strategies acquired through the instruction supported by hints and learner control may be those that are transferred to other contexts and facilitate further learning activities. As learners' confidence increases through such instruction, they may attempt to modify and improve their own metacognitive strategies even when they are not required (Kinzie, 1988).

This paper has dealt with theoretical aspects of the effects of hints and learner control in enhancing metacognitive strategies. Concerning the potential of the two design strategies, much effort needs to be devoted to research in order to verify the theory and to uncover the details of learning experiences gained through the instruction. In addition, due to the importance of strategic approaches guided by hints and learner control, research should attempt to monitor learners' conscious cognitive activities involved in their learning processes.

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Title:

Learner-Generated vs. Instructor-Provided Analysis of Semantic Relationships

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Abstract

This study compared the effects of instructor-provided vs. learner-generated analyses of semantic relationships between major concepts on structural knowledge acquisition in an introductory psychology course. One group explained the relationships on instructor-provided graphic organizers; the other group classified relationships between concepts by completing skeletal maps provided by the instructor. Increase in structural knowledge was related to practice effect for both groups; the group that generated analyses scored higher at a near-significant level. Regardless of group, there was a significant relationship between total exam score and frequency of completing the treatment exercises (an indicator of motivation).

Introduction

Learning and Semantic Networks

Our semantic networks represent our knowledge structures which enable learners to combine ideas, infer, extrapolate or otherwise reason from them. Learning consists of building new structures by constructing new nodes and interrelating them with existing nodes and with each other. The more links that the learner can form between existing knowledge and new knowledge, the better the learner will comprehend the information and the easier learning will be. Learning, according to semantic network theory, is the reorganization of the learner's knowledge structure. During the process of learning, the learner's knowledge structure begins to resemble the knowledge structures of the instructor, and the degree of similarity is a good predictor of classroom examination performance (Diekhoff, 1983; Shavelson, 1974; Thro, 1978). Instruction, then, may be conceived of as the learner's mapping of subject matter knowledge (usually that possessed by the teacher or expert) onto the learner's knowledge structure.

If we accept the conception that learning involves the reorganization of the learner's cognitive structure, then instruction involves the learner's assimilation of the expert's knowledge structure. In order to help students reorganize and tune their knowledge structures, we need instructional strategies for depicting and displaying appropriate knowledge structures to students and tools for helping them organize their knowledge structures. Instructional strategies may illustrate or convey appropriate knowledge structures to students, whereas the tools or learning strategies may help learners to acquire and refine their own knowledge structures (Jonassen, Beissner, & Yacci, 1993).

Instructional Strategies vs. Learning Strategies

Instructional strategies and learning strategies lie on a continuum that describes the level of learner involvement. An instructional strategy is a method or technique for providing instruction to learners. These strategies are implemented through instructional tactics (Jonassen, Grabinger, & Harris, 1991). For instance, an instructional strategy may recommend motivating the learner prior to instruction, which may call for tactics such as arousing learner uncertainty, asking a question or presenting a picture. A strategy aimed at teaching a concrete concept may call for the use of tactics such as matched example-nonexample pairs or deriving the criterion attributes from a set of examples. Instructional strategies provide the overall plan that guides the selection of instructional tactics that facilitate learning. Essentially, instructional strategies are instructor-provided interventions that are meant to constrain learner processing of information. The instructional strategy used in this study graphically illustrated key concepts and their interrelationships between those concepts, which attempted to map the teacher's knowledge structure onto the learners' structures.

Learning strategies are mental operations that the learner may use to acquire, retain and retrieve different kinds of knowledge or performance. The fundamental difference between instructional strategies and learning strategies is that the former are largely mathemagenic and the latter are generative (Jonassen, 1985). Mathemagenic instructional strategies control the processing of learners while leading them to learning, so they result in anticipated learning outcomes. They facilitate acquisition of specific content knowledge (intentional learning) but generally do not facilitate or even impede the acquisition of any other knowledge (incidental learning).

Learning strategies, on the other hand, are generative; that is, they enable learners to take an active, constructive role in generating meaning for information by accessing and applying prior knowledge to new material. Wittrock's (1978) generative hypothesis asserts that meaning for material presented by computer or any other medium is generated by the learner's activating and altering existing knowledge structures in order to interpret what is presented. Learning strategies are intended to increase the number of links between presented information and existing knowledge. Learning strategies, unlike instructional strategies, are more learner-controlled as well as learner-generated, because they engage the learners and help them to construct meaningful representations. Their success depends upon the learner taking an active role in controlling their use. The strategy that was investigated in this study facilitated the acquisition of structural knowledge.

Instructional and Learning Strategies for Facilitating Structural Knowledge

The learning variable that was investigated in this study was structural knowledge. Structural knowledge is the knowledge of how concepts within a domain are interrelated (Diekhoff, 1983). Structural knowledge enables learners to form the connections that they need to describe and use scripts or complex schemas. It is a form of conceptual knowledge that mediates the translation of declarative knowledge into procedural knowledge. There are a number of instructional strategies for conveying structural knowledge representations and a number of learning strategies for facilitating knowledge acquisition (Jonassen, Beissner, & Yacci, 1993). Instructional strategies that affect the way that learners encode these structures into memory include explicit graphic, mapping techniques, such as graphical organizers, spider maps, semantic maps, and causal interaction maps, for conveying knowledge structures to students. Teachers and designers may use a number of verbal instructional techniques, such as content structures and elaboration theory, to convey the underlying structures in materials to students. There are also a number of learning strategies that learners can use to build their own structural knowledge representations, including pattern noting (Buzan, 1974; Fields, 1982), networking (Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979) and the node acquisition integration technique (Diekhoff, Brown, & Dansereau, 1982).

Among these strategies is a study strategy called the *Frame Game* that was developed to accompany an educational psychology textbook (Clifford, 1981). The Frame Game is a text processing strategy that identifies the most important concepts in a textbook chapter and then requires the learner to identify the relationships between the concepts by assigning them to predetermined, mapped relationships (see Fig. 1 for a completed frame and Fig. 2 for a frame to be completed by students). This analysis strategy requires that learners search, contrast, validate, elaborate, confirm, and test

434

information from the chapter. These relationship maps may be used to engage learners in generative processing of textual information or to depict the information.

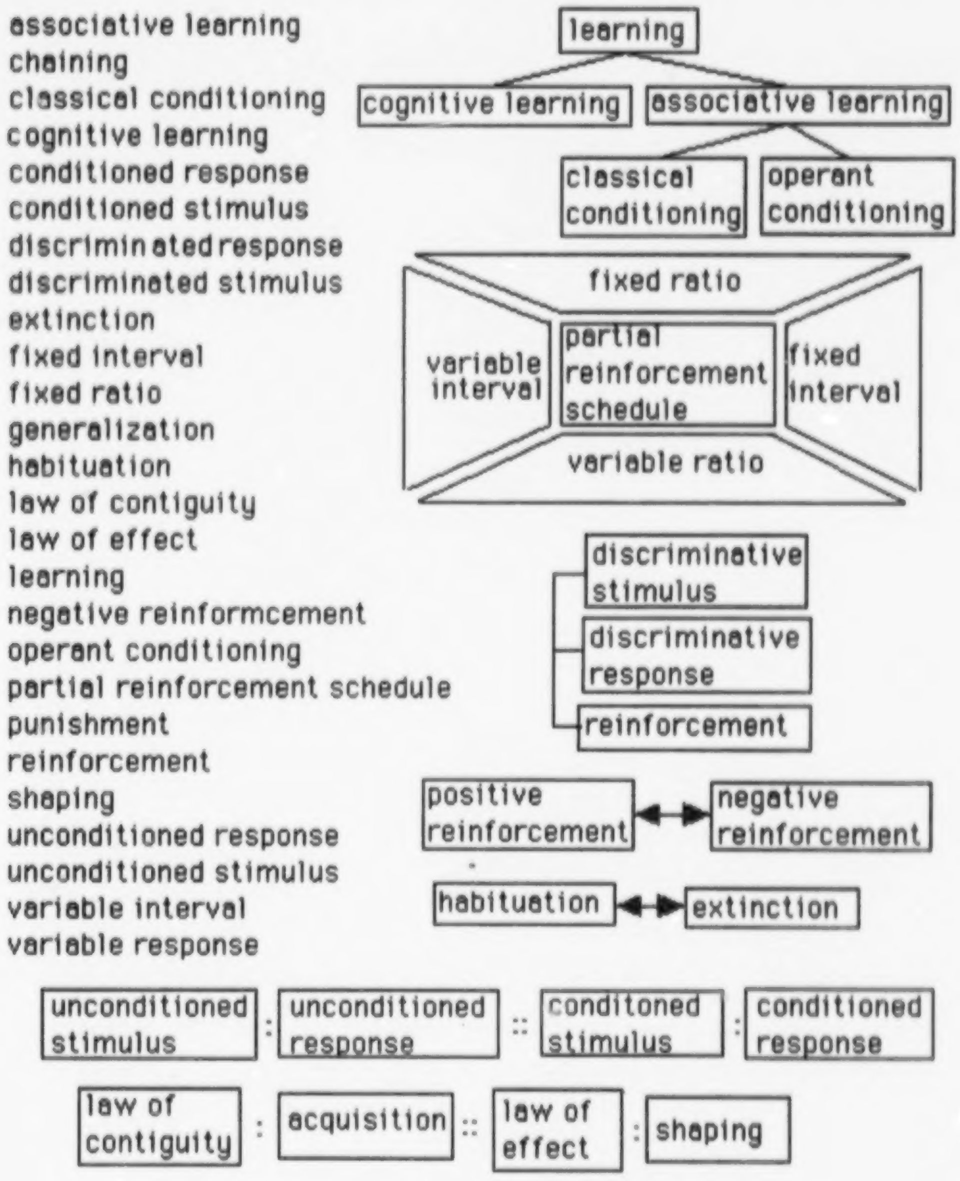
associative learning
chaining
classical conditioning
cognitive learning
conditioned response
conditioned stimulus
discriminated response
discriminated stimulus
extinction
fixed interval
fixed ratio
generalization
habituation
law of contiguity
law of effect
learning
negative reinformcement
operant conditioning
partial reinforcement schedule
punishment
reinforcement
shaping
unconditioned response
unconditioned stimulus
variable interval
variable response
learning
cognitive learning
associative learning
classical conditioning
operant conditioning
fixed ratio
variable interval
partial reinforcement schedule
fixed interval
variable ratio
discriminative stimulus
discriminative response
reinforcement
positive reinforcement
negative reinforcement
habituation
extinction
unconditioned stimulus
:
unconditioned response
::
conditoned stimulus
:
conditioned response
law of contiguity
:
acquisition
::
law of effect
:
shaping

Fig. 1. Completed frame for chapter in psychology textbook.

In this study, we compare (1) the provision of structural information to learners as a review of the information with (2) the learner analysis of the relationships between the concepts in the chapter (For a more complete discussion, see Cole & Jonassen, 1993.)

The patterns of frames in Fig. 2 represent different relationships between concepts, such as hierarchical, sequential, and associates relationships. Students have to analyze the concepts and decide which combinations can fit into the structures. Such an activity requires deep-level semantic analysis of the main ideas in the textbook and lectures.

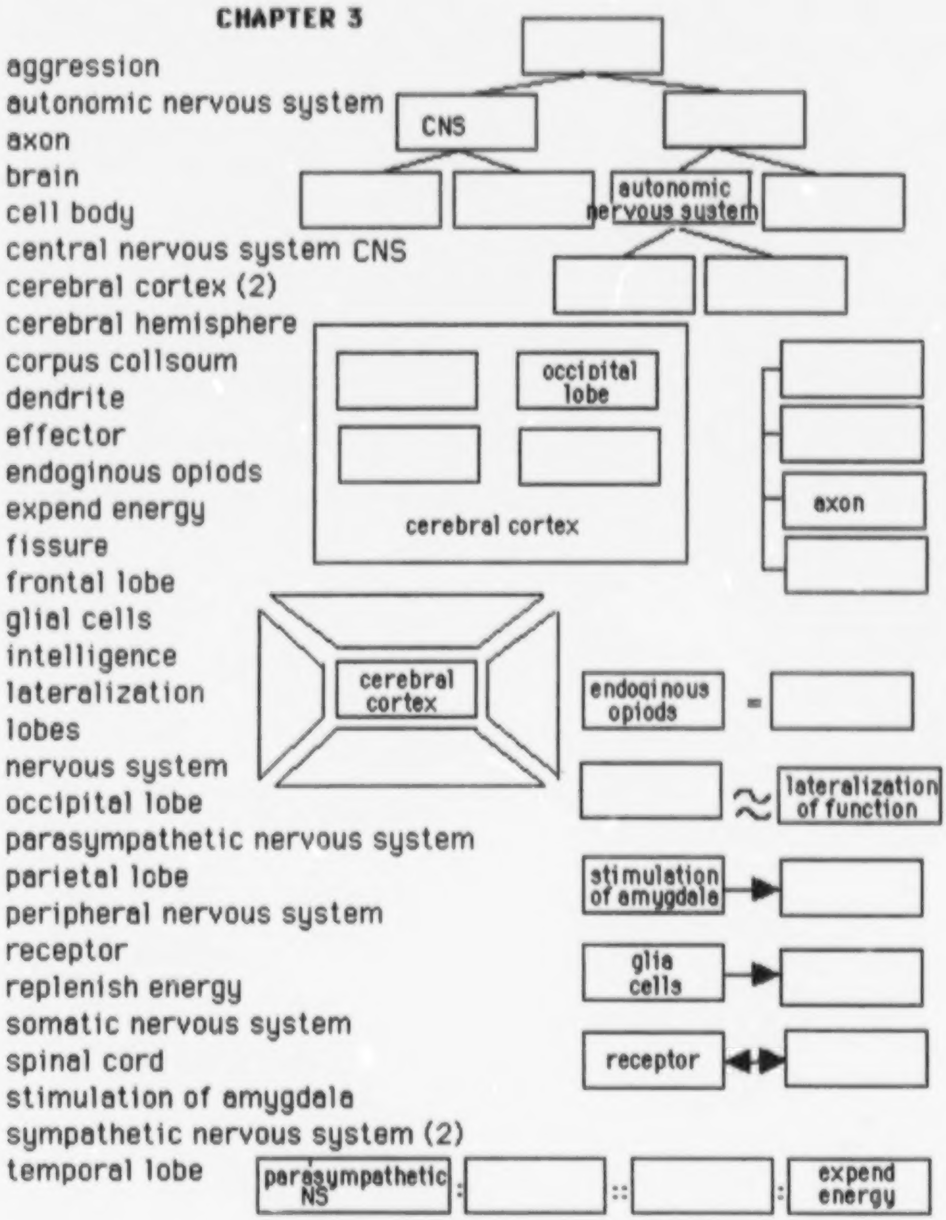
CHAPTER 3
aggression
autonomic nervous system
axon
brain
cell body
central nervous system CNS
cerebral cortex (2)
cerebral hemisphere
corpus collsoum
dendrite
effector
endoginous opiods
expend energy
fissure
frontal lobe
glial cells
intelligence
lateralization
lobes
nervous system
occipital lobe
parasympathetic nervous system
parietal lobe
peripheral nervous system
receptor
replenish energy
somatic nervous system
spinal cord
stimulation of amygdala
sympathetic nervous system (2)
temporal lobe
CNS
autonomic nervous system
occipital lobe
cerebral cortex
axon
cerebral cortex
endoginous opiods
=
≈
lateralization of function
stimulation of amygdala
glia cells
receptor
parasympathetic NS
:
::
:
expend energy

Fig. 2. Student frame from psychology textbook.

Purpose of Study

The primary purpose of this study was to clarify and extend the findings of a prior study (Jonassen, Cole, & Bamford, 1992) comparing the effects of a structural knowledge instructional strategy with the effects of a structural knowledge learning strategy on the acquisition of structural knowledge. In that study increases in structural knowledge acquisition interacted with content difficulty and the relative difficulty of the exercises. Motivation also appeared to be a factor for one Group.

In this study, we wanted not only to compare the effects of providing graphical organizers in the form of completed frames with requiring students to complete frames as a study strategy prior to examinations, but also to overcome several limitations of the previous study. First, we wanted to ensure at least minimally similar cognitive processing of the organizer and the frames by students in their respective groups. In the earlier study, students who received the organizer had not been required to process it in any way. Moreover, the students who received the organizer might have engaged in rote memorization or some form of verbal mediation. Second, since incentives play an important role in student performance (Hicken, Sullivan, & Klein, 1992) we wanted to provide adequate incentive for completing the exercises. Third, since it apparently takes months for a new learning strategy to displace a well-established old one (Duffy & Roehler, 1989), we wanted to have students utilize a single strategy for an entire semester; in the earlier study students used each strategy for one exam in a counter-balanced research design. Fourth, we wanted to eliminate the confounding effect of the counterbalanced design since we could not control the difficulty level of each chapter. The results of the prior study suggest that it is more difficult to assimilate structural knowledge for some chapters than for others. For example, it is easier to relate learning and memory concepts to a class of college students than it is concepts on physiology. Finally, we wanted to include enough items on each subscale of structural knowledge to be sensitive to learner performances on each exam.

Method

Subjects

Thirty-eight students from two sections of a General Psychology (Psy 101) course at a large community college in metropolitan Denver completed the study during eight-week summer term, 1992. Five other students failed to complete all of the tests so they were dropped from the analysis. There were 21 subjects in Group 1, and 17 in Group 2.

Instruments

Four subject-matter exams were designed for the experiment. Each exam consisted of 60 questions worth one point each, 34 of which were multiple-choice questions testing recall and comprehension of the text and lecture material. In order to assess structural knowledge acquisition following various treatments, we developed three subscales to measure different aspects of structural knowledge: (a) 10 relationship proximity judgments, (b) 8 semantic relationships, and (c) 8 analogies. All of the structural knowledge test questions were developed to focus on relationships between important concepts contained in the textbook chapters.

The relationship proximity judgments required that students judge the strength of the relationship between two terms and assign a number between 1 and 9 to each of several pairs of concepts to indicate how strong a relationship they thought existed between the concepts in each pair (Diekhoff, 1983; Schvaneveldt, Durso, Goldsmith, Breen, Cooke, Tucker & DeMaio, 1985; Shavelson, 1972). For example:

_____ 2. endorphins — amygdala

_____ 3. cerebral cortex — Broca's area

_____ 4. seratonin — temporal lobe

The semantic relationships subscale consisted of eight multiple-choice questions that required students to understand and recognize the nature of the relationship between two concepts. These relationships were paraphrased from the textbook or lecture. For example:

_____ 16. sensory registers .... short term memory
  a. precedes
  b. is defined by
  c. is independent of
  d. is inferred by

_____ 17. acoustic .... memory
  a. results in
  b. is independent of
  c. is opposite of
  d. is an example of

Finally, the analogies subscale required students to complete eight analogies consisting of four of the concepts from the textbook or lecture. For example:

_____ 22. decay : forgetting :: _______ : retrieval
  a. mood
  b. repression
  c. rehearsal
  d. primacy

_____ 23. acquisition : extinction :: punishment :_____________
  a. negative reinforcement
  b. positive reinforcement
  c. variable reinforcement
  d. classical conditioning

These three types of questions were used to assess structural knowledge acquisition. In order to provide standards for assessment, the researchers agreed on the answers to each of these questions. Answers to the multiple-choice questions were recorded on the front of Scantron answer sheets; semantic-proximity items were written on the back. Exams covered history and methodology of psychology (chapters 1 & 2), physiology, sensation and perception (chapters 3 & 4), learning and memory (chapters 6 & 7), and motivation, emotion, and states of consciousness—primarily sleep (chapters 5, 9, & 10).

Materials

Researcher-generated study maps were generated for each chapter; mapping allowed students to visualize the relationships among terms — superordinate/subordinate/coordinate (hierarchical) and sequential organization—as well as the depiction of the terms in classes, analogies, similarities, cause and effect, and opposites (see Fig. 1). Each map alphabetically listed all the terms used in the frames. Students were also instructed to study the list of terms at the end of each chapter in the text.

Templates of maps were designed for a student-generated-mapping exercise to be assigned prior to Exam 2. These maps (see Fig. 2) were the same as the instructor-provided maps in Fig. 1 except that most of the frames in the maps were empty, requiring the student to fill in the appropriate concepts. Since a prior study (Jonassen, Cole, & Bamford, 1992) indicated that having extra terms in the list made the cognitive load too great, the lists in this study included only the terms actually used in the frames. To further optimize the cognitive demands on the students, the templates provided at least one term in each set of frames (always one in each pair of terms in an analogy).

Procedure

The study was a quasi-experimental design using intact psychology classes. The classes met 150 minutes twice a week at 9:50 a.m. (Group 1) and 6:30 p.m. (Group 2) for the duration of an 8-week summer term. One of the researchers served as instructor for both sections of the course.

A repeated-measures design was utilized to assess learning across the semester and to measure group differences.

	Group 1	Group 2
Exam 1	Maps Provided	Maps Provided
Exam 2	Maps Provided	Maps Generated by the Class as a Whole
Exam 3	Maps Provided	Maps Generated in Small Groups
Exam 4	Maps Provided	Maps Generated Individually

Prior to Exam 1, students acquired mapping concepts and procedures by completing a generic mapping exercise. This exercise introduced students to the mapping process that they would encounter throughout the semester. Students were told that they would be involved in a study about using learning strategies.

One week prior to Exam 1, a study sheet containing key terms from lecture and text was distributed. The class prior to the exam was partially devoted to explaining the key terms' relationships within the instructor-provided maps that were distributed to both groups. Exam I covered chapters 1 and 2 (history & methodology of psychology).

One week prior to Exam 2, a study sheet containing key terms from lecture and the text was distributed to both groups. A portion of the class period immediately prior to the exam was devoted to the mapping exercise. Group 1 received instructor-provided maps; students were required (as a homework assignment) to explain in writing the mapped relationships. Group 2 students received the templates designed for student-generated-mapping, and the teacher facilitated whole-class problem solving of how to complete the maps correctly. Exam 2 covered chapter 3 and 4 (physiological psychology, and sensation and perception).

One week prior to Exam 3, a study sheet containing key terms from lecture and the text was distributed to both groups. As with Exam 2, a portion of the class period prior to the exam was devoted to the mapping exercise. As before, Group 1 students were required (as a homework assignment) to provide a written explanation of each graphically mapped conceptual relationship in the instructor-provided maps. Group 2 students received the templates designed for student-generated-mapping. Students divided into groups of 3-4 students and completed the mapping exercise in class. Exam 3 covered chapters 6 and 7 (learning & memory).

One week prior to Exam 4, a study sheet containing key terms from the lectures and the text was distributed to both groups. As before, Group 1 students were required to provide a written explanation of each graphically mapped conceptual relationship in the instructor-provided maps. Group 2 students received the templates designed for student-generated-mapping. Group 2 students were required to complete this exercise individually as a homework assignment. Exam 4 covered chapters 5, 9, and 10 (motivation, emotion, and states of consciousness—primarily sleep).

Following each exam, the instructor reviewed the exam in class and provided feedback on each student's test performance. Homework assignments (written descriptions of maps for Group 1, and student- or group-generated maps for Group 2) were assessed for degree of completion; the homework assignments altogether counted 10% of the course grade.

At the end of the semester, students were administered a questionnaire designed to assess their perceptions of the mapping strategies that were presented in class.

Exam items included 34 general recall/comprehension items, and 26 structural-knowledge items—8 analogies, 8 relationships, 10 proximities—for a total of 60 questions per exam. Scores on each dependent measure of interest were converted to percentages so that they could be compared across scales and subscales. These dependent measures were all analyzed using a repeated-measures analysis of variance (ANOVA). Because we assumed that students in each treatment were learning to apply their respective mapping strategies on the exercises for Exams 1 and 2, analyses focused on Exams 3 and 4.

Results

Total Exam Scores

An ANOVA of the total exam scores for Exams 1 and 2 indicated no statistically significant differences between Groups 1 and 2. This was the period in which the learners were practicing their respective skills; so analyses focused on Exams 3 and 4. No significant differences in the total scores occurred between groups or between exams (see Fig. 3).

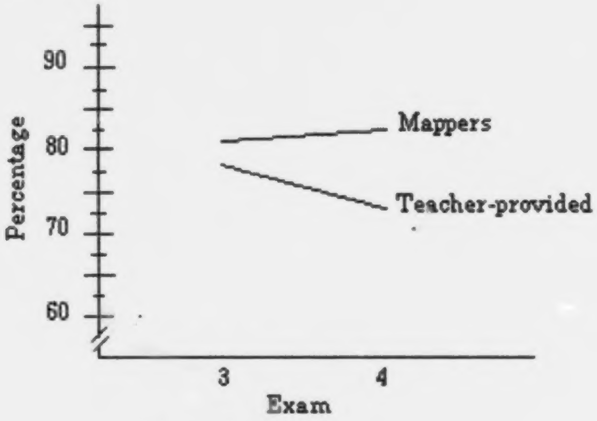

Fig 3. Total exam scores

Group 1 (teacher-provided) scores declined five percentage points on Exam 4, while the mapping group's score increased slightly. However, the interaction was not significant ($p = .10$). Next we wanted to determine if completion of the assigned exercises contributed to total exam performance. The total number of maps completed by all subjects were summed and classed into three groups: those who completed only a Few of the maps, those who completed Most of the maps, and those who completed All maps. Total scores were significantly different between these groups (M= 67, 78, 85 for Exam 3 and 68, 72, and 85 for Exam 4 for the Few, Most, and All groups respectively; $F = 7.4, p < .01$), but the treatment group by completion group was not significant. The treatments did not appear to differentially affect total exam performance. Next we analyzed the three subscales for structural knowledge (proximities, semantic relationships, and analogies).

Structural Knowledge Performance

Proximities. Student proximity scores were compared with experts' scores, yielding a correlation coefficient for the 10 proximity items on each exam. These coefficients were compared using ANOVA (see Figure 4).

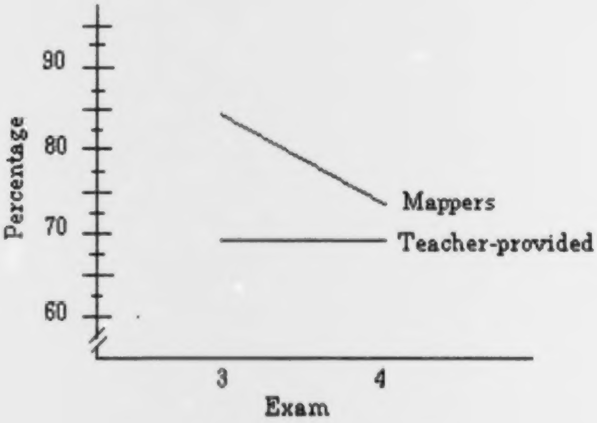

Figure 4. Total proximities score

A significant main effect occurred for treatment ($p < .05$), with the mapping-group scores ($M = 79$) exceeding the teacher-provided group scores ($M = 69$). The repeated measures by group interaction neared significance ($p = .06$), with the teacher-provided group's scores remaining stable between Exams 3 and 4 and the mapping group's scores declining significantly. This difference becomes even more dramatic in a comparison of intentional learning (mapped items) and incidental learning (unmapped items; see Fig. 5).

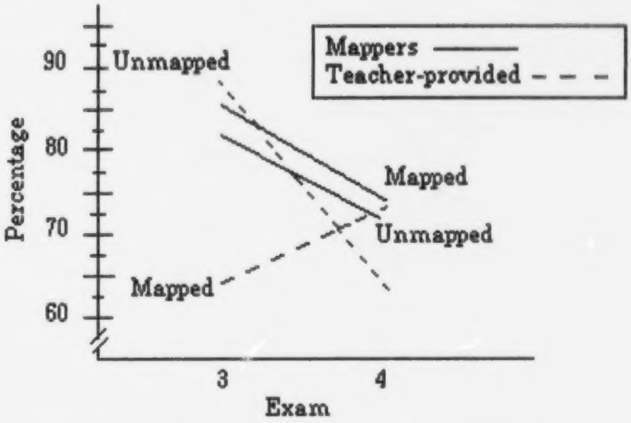

Fig. 5. Mapped and unmapped proximities

On mapped proximity items, the teacher-provided group's scores increased significantly while the mapping group's scores decreased significantly ($F = 6.3$, $p < .05$). The interaction on the unmapped proximities (incidental learning) was not significant. This indicates that the content of Exam 4 was more difficult than Exam 3 and that the mapping group was impeded by some aspect of that Exam.

Semantic relationships. On the relationship items, there was a significant repeated measures effect ($F = 10.4$, $p < .01$; see Fig. 6) and a significant difference between those who completed Few, Most, or All of the mapping exercises ($p < .01$ for both exams).

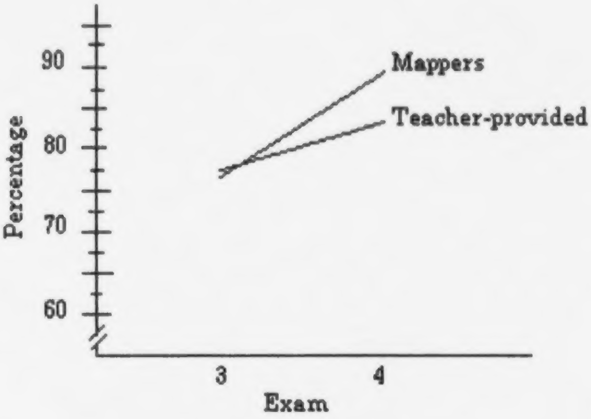

Fig. 6. Total relationship scores

The scores of both groups increased from Exam 3 to Exam 4, indicating a significant practice effect. As with the proximity items, those who completed All of the exercises outperformed those who completed Most and those who completed just a Few of the map-related exercises assigned during the term. Unlike the proximity items, there was a significant repeated measures by group interaction on intentional learning (mapped items), with the teacher-provided group maintaining a steady performance between Exams 3 and 4 and the mapping group increasing its performance (see Figure 7). There was a significant repeated measures effect for incidental learning, with both groups improving their performances between Exams 3 and 4 (see Figure 7).

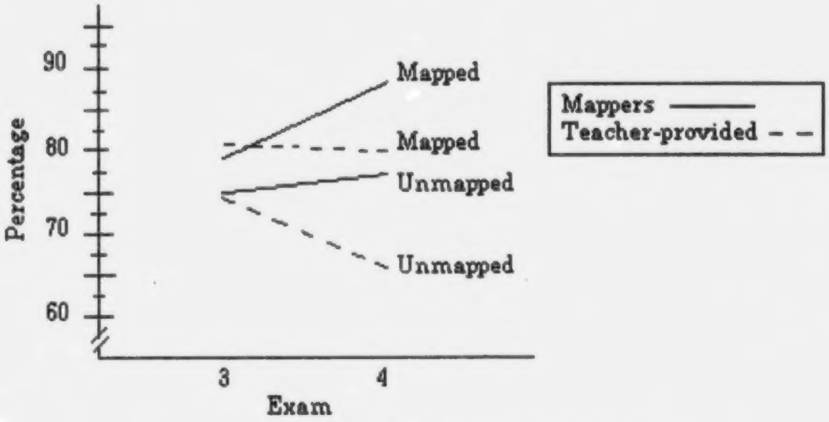

Fig. 7. Mapped and unmapped relationships

Analogies. There was a significant repeated measures by treatment interaction on the analogies ($F = 6.7, p < .05$), with the teacher-provided group declining and the mapping group improving (see Fig. 8). There were too few mapped analogies for any meaningful interpretation of intentional learning. However, there was a significant repeated measures by treatment interaction for incidental learning ($F = 6.7, p < .05$), with the teacher-provided group declining and the mapping group improving (see Fig. 8).

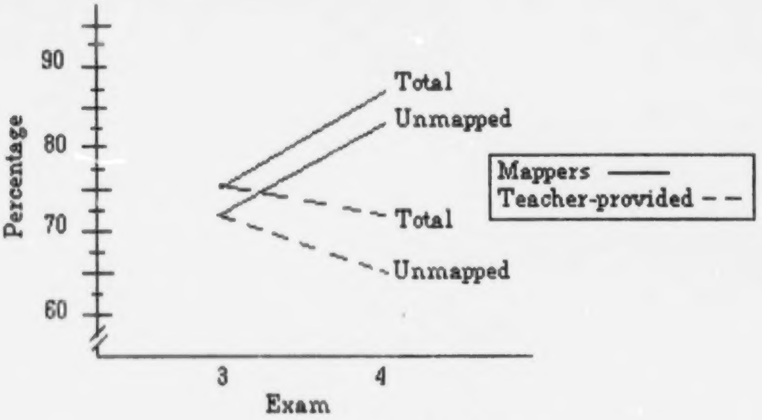

Figure 8. Analogy Scores

Non Structural Knowledge Performance

The first 34 items of the test were predominantly recall and comprehension items. There was a significant practice effect for the total score on this section of the test ($F = 8.5, p < .01$) as well as on the recall items ($F = 27.8, p = .0001$). Both groups declined on both measures between Exams 3 and 4 (see Fig. 9).

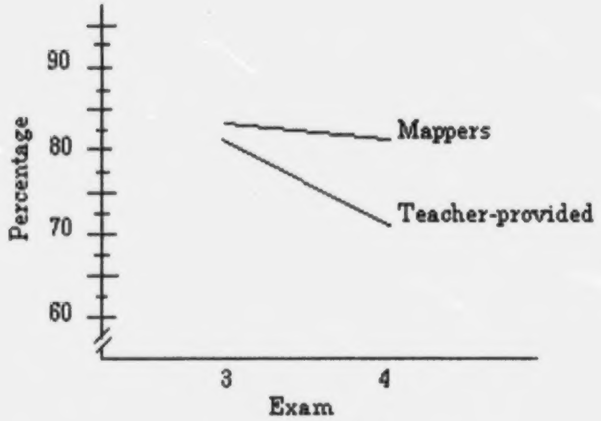

Fig. 9. Non-structural knowledge total scores

A repeated measures ANOVA revealed that both groups declined significantly in intentional learning (F = 4.7, p < .05), and incidental learning (F = 14.6, p .0005; see Figure 10). These findings confirm the above interpretation that the content of Exam 4 was more difficult than the content of Exam 3.

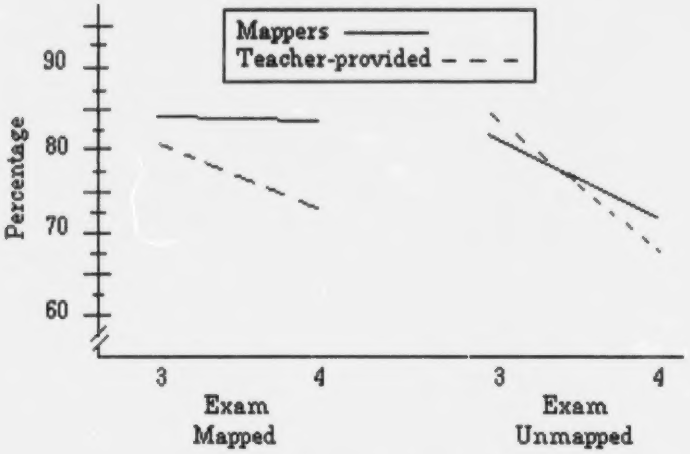

Fig. 10. Mapped and unmapped non-structural knowledge

Discussion

The most consistent result is based upon the number of mapping exercises completed by each group. Confirmatory regression analyses regressing the number of exercises completed onto each of the dependent variables resulted in significant predictive value for the number of exercises students completed (*p* < .01). Clearly, both treatments engaged the learners in some deeper level thinking.

However, the results of this experiment were not as distinct because the nature of the treatments were so similar. In this study, we over-compensated for problems experienced in the previous study. The processing that the two strategies required was fairly equivalent, though slightly more difficult for the group who completed their own maps. That is, there was not a sufficient difference between the instructional strategy and the learning strategy used in the study. The difference in performance was most obvious on the analogy questions, which students always find most difficult. In subsequent research, the activities should be more clearly distinguished.

In general, students performed better on intentional learning (items cued by the maps) than on incidental learning. The significance of this difference is more complex than it at first seems, since few of the test items were directly represented on the maps. Moreover, with the exception of the proximity items (the most nebulous of the structural knowledge items), the mapping group generally outperformed the teacher-provided group on both intentional and incidental learning. Thus the more generative strategy seems to have facilitated both intentional and incidental learning more than did the more instructor-supported strategy. However, it is again important to note that the strategies involve relatively similar degrees of instructional support. Results of a prior study by Jonassen, Cole and Bamford (1992) suggest that placing heavier cognitive demands on learners can be counter-productive.

Future Research

This study only began to address the many questions about how best to support the acquisition of structural knowledge. Future studies must address, for example, (a) the relationship between individual learning characteristics (e.g., verbal ability, and field dependence/independence), (b) how much instructional support is optimal (the results of this study, combined with those of the previous study by Jonassen, Cole, and Bamford (1992), challenge the assumption that the more the learner generates, the more he/she will learn), (c) what concepts to map, (d) how to depict concepts (e.g., Do different types of frames differentially facilitate the acquisition of specific types of structural knowledge?), (e) the role of incentive in such studies (the current study may not have provided adequate incentive; would greater incentives increase the effects?). Future research with college-level students should also include a control group who invoke their own strategies.

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Title:

Distance Education: A Cost Analysis

Authors:

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Michael Simonson

TABLE OF CONTENTS

INTRODUCTION 1
REVIEW OF LITERATURE 2
  Distance Education 3
  Distance Education Today 3
  The Economics of Distance Education 4
  Distance Education and Technology 4
  Transmission Systems 5
    Fiber Optic Systems 5
    Microwave Systems 7
    Compressed Video Systems 8
  Distance Education Classrooms 9
METHODOLOGY 12
  Data Collection 12
  Procedures 13
RESULTS 13
  Costs 13
    Fiber Systems 13
    Microwave Systems 14
    Compressed Video Systems 16
  Other Results 17
  Distance Education Classroom Costs 18
SUMMARY 20
  Conclusions 21
BIBLIOGRAPHY 22

TABLE 27

APPENDIX A- Considerations For Distance Education Systems 28

APPENDIX B - Cost Estimates For Fiber Systems 29

APPENDIX C - Cost Estimates For Microwave Systems 30

APPENDIX D - Cost Estimates For Compressed Video Systems 31

APPENDIX E - Classroom Designs and Equipment Lists 32

DISTANCE EDUCATION: A COST ANALYSIS

by
Judy I. Jones
Michael Simonson

INTRODUCTION

The concept of distance education is enlarging the definitions of how students learn, where they learn, and who teaches them (U. S. Congress, 1989). In the past, distance education was of greatest importance to adults. Recently, there have been increasing numbers of distance education opportunities offered to high school students, and even elementary schools have taken advantage of enrichment activities offered to children from distant sites.

Distance education has become increasingly sophisticated since the first educational radio programs. Barker (1989a) referred to distance education as a "catch all" phrase for any form of instruction in which the learner and instructor were separated geographically and were linked by telecommunication systems that permitted live, interactive audio and/or video exchanges.

Definitions of distance education usually include Keegan's (1986) characteristics:

- quasi-permanent separation of teacher and learner,
- influence of an educational organization,
- use of technical media,
- provision of two-way communication, and
- quasi-permanent absence of group learning.

Keegan also includes the following characteristics as ones that are often part of distance education systems:

- presence of industrialized features, and
- privatization of institutional learning (p. 49-50).

Distance education systems that use two-way interactive telecommunications have the following features. The instructor is at an origination site and students are at a remote site; students may be present at the origination site as well. Instruction is influenced by an educational organization--the school. Sites are connected point-to-point with fiber, microwave, or twisted pair copper media, often referred to as compressed video. This allows two-way interactive video, data, and/or audio communication and permits live interaction between instructor and students, with instruction directed to one or more students.

In this study, the term "compressed video" refers to video signals that have been digitized and significantly compressed so they can be transmitted using traditional transmission media, including twisted pair copper wire. The terms fiber and microwave refer to the media for transmitting video and data signals, and compressed video refers to a technique for modifying a video signal. Although they are not directly related, the three terms (fiber, microwave, and compressed video) are used in the study because they are commonly cited in distance education literature.

We would like to acknowledge the Office of Telecommunications and the Media Resources Center at Iowa State University for their review of the technical information in this monograph.

The trend in distance education in the United States is to provide distant learners with live, two-way interactive instruction. Quality distance education is dependent on interaction and participation of learners. The goal of implementing an interactive system is to make distant education situations as close to traditional instruction as possible.

Today, the technical capabilities exist for schools to provide distance education opportunities to students. While advances in technology make it possible for school districts to improve their curricula and learning experiences, the use of technology also creates new problems. Technology is expensive and complicated, and some question the propriety of using telecommunications to offer courses to students located at remote sites.

Administrators, school boards, and policy-makers often ask about how much distance education costs. Since distance education systems require significant cost commitments, those responsible for making large capital investments must have reliable data available to them to help them in the decision making process.

First, this study compares the costs of three types of transmission technology. Two of the technologies deliver two-way, full motion video and two-way audio: (a) fiber optics and (b) microwave. The third technology, compressed video, also delivers two-way audio and two-way video, but uses a computer device to "compress" the signal.

Second, this study describes costs for equipping and installing a distance education classroom. Lists of equipment and prices are supplied.

The following research questions guided the preparation of this report.

(1) What are the characteristics, advantages, and disadvantages of the three transmission technologies?
(2) What does it cost to put into place a point-to-point, distance education system using fiber, microwave, and compressed video?
(3) What are the major cost considerations for the three transmission methods?
(4) How do the costs vary for distances of 3 miles, 10 miles, 20 miles, 30 miles, 50 miles, and 75 miles?
(5) What are the recurring and maintenance costs for the transmission equipment?
(6) Is it usually better to lease or purchase?
(7) What does it cost to equip an interactive distance education classroom?
(8) What are the recurring and maintenance costs for the classroom equipment?

Distance education is a viable way to enrich and improve the quality of the curriculum. Technology can link teachers and learners from all educational levels--elementary, high school, and college, as well as business and community --and bring a wide variety of expertise and information to the classroom. Costs can be justified by an increase in educational opportunities (Giltrow, 1989).

REVIEW OF LITERATURE

This review of the literature summarizes research related to distance education and key variables of this study. The information in this section is organized in the following categories: (a) a brief description of theories of distance education; (b) the impact of distance education today; (c) the economics of distance education; (d) distance education and technology; (e) transmission systems; and (f) the interactive distance education classroom.

Distance Education

There are two views on the concept of distance education - distinctive and parallel.

Distinctive form. Many consider distance education to be a distinctive educational form based on individualized study. Many autonomous universities teach only to students at a distance and believe that distance education is a distinct form of education (Moore, 1988; Peters, 1988).

Considerable effort has been spent trying to formalize a theory specific to distance education. Keegan (1988) grouped the theories as follows: (a) ***theories of autonomy and independence***:; (Wedemeyer, 1981; Moore, 1988); (b) ***theory of industrialization;*** (Peters, 1988); and (c) ***theories of interaction and communication***; (Holmberg, 1977, 1981, 1988a, 1988b; Baath, 1980; Sewart, 1988). Keegan (1980, 1986) analyzed the theories presented by Moore, Peters, and Holmberg to create the descriptive definition of distance education summarized above. It is the definition used most widely today.

Parallel form. A second perspective considers distance education as parallel to traditional education. Garrison (1989) asserts that distance education is not unique. The techniques appropriate for traditional education systems and distance education systems are the same. Many educators in the United States subscribe to the philosophy that distance education does not differ from conventional education in any real structural sense, but is distinctive only in the delivery system (Zigerell, 1984).

Distance Education Today

Applications of distance education have increased dramatically during the last five years. Fewer than ten states were promoting distance education in 1987, while today virtually all states have an interest or effort in distance education (U. S. Congress, 1989). Distance education programs exist in the majority of countries in the world. This growth is primarily due to increases in educational requirements that have coincided with the expanding capabilities and services of the telecommunications industry (Giltrow, 1989). The quality of distance learning has been recognized with increasing respect and credibility (Turnbull, 1988). Distance education has been seen as a viable and cost-effective way to meet the challenges of teacher shortages, low student enrollments, and decreased funding.

Jefferson and Moore (1990) predict that all rural schools will have distance education service by 1995. A UCLA study predicts that, by the year 2010, 50 percent of the educational instruction in the United States will be "mediated education" (cited in Pelton, 1990).

The success of interactive distance education classes is well documented. Studies have supported the following conclusions:

- Students involved in distance education classes have reported positive feelings about their experiences (Barker, 1989b; Catchpole, 1988; Kitchen & Kitchen, 1988; Nelson, 1985; Nelson, Cvancara & Peters, 1989; Pirrong & Lathen, 1990; U. S. Congress, 1989).
- After teaching in an interactive distance education system, faculty have had positive responses about the experience (Barker, 1989b; Bowman, 1986; Hobbs, 1990; Kitchen, 1987; Randall & Valdez, 1988; U. S. Congress, 1989).
- Student achievement in interactive distance education classes has been as good or better as that of students learning from traditional teaching methods (Batey & Cowell, 1986; Hobbs, 1990; Kabat & Friedel, 1990; Minnesota State Department of Education, 1990; Pirrong & Lathen, 1990; Randall & Valdez, 1988; U.S. Congress, 1989).

The Economics of Distance Education

Economic implications of using distance education methods can be generalized as follows: (a) significant costs are incurred irrespective of student numbers, (b) transmission and production costs are high for systems, (c) conventional, non-distance education system costs are recurring costs and vary according to the number of students; distance system costs can be regarded as fixed costs and amortized over the life of a course, (d) from an economic point of view, investment where student numbers are small is normally not warranted, and (e) administrative functions are more clearly differentiated from the academic functions in distance education systems; distance systems are more complex (Rumble, 1982, p. 119).

One of the most significant factors when planning a distance education system is the cost. A large portion of the expenses are start-up costs, which in effect, can be the equivalent of five years worth of teacher costs. To some, paying these costs before enrollment revenues are collected is unsettling (Giltrow, 1989), and is only acceptable if costs can be amortized over a long period of time (Perraton, 1982). Factors that affect costs of establishing a system are (a) type of technology, (b) distance and topography, (c) existing and available technology, (d) possible partnerships, (e) engineering requirements, (f) remodeling needs, and (g) lease/purchase arrangements. Operating and maintenance costs are also significant (Shobe, 1986). These costs, sometimes referred to as recurring costs and fixed costs, include service and repair, license fees, maintenance fees, and lease fees. The amount of money required to establish a system is often seriously underestimated (Rumble, 1986b). Obviously, personnel and curriculum costs to train instructors and revise materials are considerable, too.

In general, three factors influence the economics of distance education: choice of media, size or type of program, and number of students (Batey & Cowell, 1986; Rumble, 1982). Although Rumble concludes that "distance learning is not necessarily a cheap way of teaching" (p. 137), the large capital investment will pay off in cost-efficiency if there are sufficient numbers of students. Markowitz (1990) maintains that distance education programs are predominantly self-sufficient.

Evidence also is available to support the conclusion that distance education is effective when effectiveness is measured by achievement, by attitudes of students and teachers, and by cost-effectiveness. Generally, the evidence has indicated that distance education "works."

Distance Education and Technology

Telecommunications is defined as communicating over a distance. Rapid advances in technology, deregulations of these technologies, and decreases in costs have made telecommunications attractive to schools.

Telecommunications systems are often referred to by the medium, the type of information (signal) transmitted, and the direction flow. The type of information includes audio, video, and data signals. The media for communication are usually radio waves through the air, electronic impulses over transmission lines, or light through fiber made of glass or plastic silicon. The flow is defined as one-way (simplex) or two-way (duplex).

One-way communications are usually referred to as broadcast systems and are usually "top-down" communications in which the information is transmitted by electromagnetic waves to anyone with a receiver. Signals may also be transmitted to an orbiting satellite and then broadcast to receivers on the ground. There is uniformity in the programs offered and usually no direct interaction. These one-way systems are also referred to as point-to-multi-point. Television broadcasts are examples of one-way communications.

In a two-way system, points are linked through a network and tend to encourage "bottom up" and lateral communications. They often involve live, real-time interaction between individuals at two or more places. This communication, often referred to as point-to-point or narrowcasting, is directed to a specific audience.

Two-way interactive television (ITV) and distance education. The term ITV originally referred to instructional television, but today has become synonymous with interactive television. Today's ITV technologies allow for live, two-way communication between sites. In the ITV classroom, the students and teacher see and hear one another. ITV has been shown to be comparable to the traditional method of instruction, both in terms of teacher and student acceptance and in achievement (Hughes, 1988). The Office of Technology Assessment reported that television-based interactive instruction is the distance education format that most closely resembles the traditional classroom; this has been the format of choice for many U.S. distance education systems (U. S. Congress, 1989).

Bates (1988), Feasley (1983), and Gray (1988) state there is a clear movement away from using broadcast methods for distance learning systems. "In the 1990s, it is no longer a question of whether ITV is going to become a major factor in the delivery of education. ITV is here, and there is obvious value in its use as a delivery tool" (Moore & McLaughlin, 1992, p. 76).

Transmission Systems

Since it is possible to discuss distance education systems from a number of perspectives, this monograph examines the costs for establishing a system by studying three forms of technology that are often used to characterize particular systems: fiber-based systems, microwave systems, and compressed video systems that use existing transmission networks. As was stated earlier, the three are not directly comparable. However, when distance educators discuss systems, they often categorize them in this manner.

Fiber Optic Systems

Fiber optics is one of the newest two-way, interactive technologies. The fiber, made of glass or plastic, transmits light signals instead of electrical signals. An optical fiber consists of an inner cylinder called the core, surrounded by a cylindrical shell of glass or plastic called the cladding. The cladding layer keeps light from leaking out. An outside coating provides protection against the elements. Light travels in straight lines, but optical fibers guide light around corners. The number of fibers is unlimited, creating virtually an unlimited capacity. Optical cables are capable of transmitting far more information than coaxial cables of the same size.

Equipment required for a fiber system. The main components of a digital fiber system are: (a) multiplexor; (b) codec; (c) optical transmitter; (d) optical receiver or photodetector; (e) fiber cable; and (f) repeaters.

The multiplexor converts the signal to/from an electrical signal. The codec changes the signal to digital. The optical transmitter converts the signal to an optical signal, and the receiver reconverts the optical signal. Transmitters are of two types, lasers (ILD) or light emitting diodes (LED). The receivers are either positive-intrinsic-negative (PIN) or avalanche photodiode (ADP). Generally speaking, the ADP is used for systems greater than 100 km (62 miles) and PINs are preferred for shorter distances. The repeater is a signal amplifi-cation device often used along cables to extend transmission distances. The fiber cable carries the optical signal. Single mode and graded index fiber is best suited for long distances. Since a codec is needed only for digital transmission, an analog system would eliminate need for the codec. A modulator/demodulator would replace the multiplexor unit; additional amplifiers would be necessary. Life expectancy of this equipment is 20-25 years.

Advantages of a fiber system.

- The large bandwidth of fiber allows audio, video, and data to be combined on one line, resulting in a lower cost per channel.
- Fiber permits full motion video transmissions.
- The low attenuation rate allows for transmissions over long distances without distortion.
- The large capacity for channels means the system can be easily expanded.
- There is maximum signal security with little possibility of tapping, eavesdropping, jamming or metal detecting.
- The small, lightweight cables are easy to handle and install.
- Fiber is unaffected by weather, corrosive liquid, or gas.
- Fiber is unaffected by electromagnetic currents, static interference, electric motors, fluorescent lights, and radiation.
- Durable fiber results in low maintenance costs.

Disadvantages of a fiber system.

- Systems require high start-up costs.
- Special tools and tests are needed to install the fiber.
- Repairs can be time consuming and costly.
- Light sources have limited lifetimes and associated system reliability problems.
- Expansion is expensive if no fiber exists.
- Right-of-way costs for placing cables in the ground can be costly.

Successful users of fiber systems. The following groups have reported on successful use of fiber-based systems: (a) MSET--Mid-State Educational Telecommunications Cooperative, Minnesota (Giltrow, 1989; Kitchen, 1987; Kitchen & Kitchen, 1988; Lanier, 1986); (b) SHARE-ED Oklahoma Panhandle Video Network (Barker, 1989b; Currer, 1991); (c) Mississippi 2000 (Currer, 1991); (d) Bergen County, New Jersey (Daley, 1991); (e) FOCIS--Fiber Optics Communication Instruction System, Des Moines, Iowa (Ostendorf, 1989a; Schoenenberger, W., personal communication, April 14, 1992).

Opinions about fiber systems. "It is possible to confidently claim that this [fiber optics] is one of the more important technological advances of the past 20 years" (Giltrow, 1989, p. 55). Fiber optics is increasingly being chosen as the preferred method of transmission by Minnesota schools because of the possibility of future expandability (Minnesota State Department of Education, 1990). Fiber lends itself well to two-way, interactive television because of its large channel capacity (Kitchen, 1987). The cost of fiber cable is widely expected to fall below coaxial or copper cables in the early 1990s (U. S. Congress, 1989); it will be competitive with microwave and coaxial cable (Kitchen, 1987). The cost/performance ratio for fiber continues to improve. In the last ten years, fiber transmission has become the medium of choice in telephone applications (Szentesi, 1991). Currer (1991) reported that digital fiber gives the user the most benefit for the money spent. Barker (1989b) believes that fiber offers the best audio transmission quality, while Lanier (1986) suggests that fiber is superior to microwave, ITFS, and coaxial because of its higher image quality.

General costs for fiber systems. The Office of Technology Assessment reported that the equipment needed to connect one site to a fiber network would cost approximately $40,000. Fiber for a 134 mile network would cost approximately $8,955 per mile. The receiving site would need $40,000 worth of equipment, also (U. S. Congress, 1989, p. 174).

Maintenance costs average one percent of system cost per year (National School Board Associ-ation, 1989). Other vendors feel that up to 13% of the cost of a system should be reserved for maintenance. Fiber systems require little maintenance; however, if the fiber is accidentally cut, repairs are very expensive and time consuming.

Microwave Systems

Microwave signals are transmitted electromagnetically through the air. Microwave is similar to standard broadcasting, except microwave systems use much higher frequencies and are point-to-point. Each tower in a microwave relay system picks up the signal sent to it, amplifies the signal, and retransmits it to the next line-of-sight tower on the way to the destination point. Prior to the development of satellite communication, microwave transmission represented the only reliable form of intercity and coast-to-coast video communication (Hart, 1986).

"Long haul" systems use a number of repeaters and cover hundreds of miles. "Short haul" systems are used where traffic loads are relatively light, or where the length of the route is short. The typical range of 5 to 15 miles is suitable for local communication between two schools. The distance between repeaters depends upon (a) topography, (b) antenna size, (c) transmitter power, and (d) receiver sensitivity. A good rule of thumb is to consider microwave if two sites are more than one-half mile but less than 20 miles apart. A good use of a microwave system is to link two buildings in the same metropolitan area. Short haul systems are relatively simple to construct and operate, and do not require regulatory agency approval or right-of-way clearance (Ostendorf, 1989a).

Equipment required for a microwave system. The main components of a microwave system are (a) tower, (b) antenna, (c) antenna feed line, (d) transmitter/receiver, (e) modulator/multi-plexor, and (f) power unit.

Advantages of a microwave system.

- Microwave permits the transmission of full motion video.
- There is control over who receives the signal.
- Audio and video signals are of excellent quality.
- Numerous data and audio signals can be transmitted along with video channels.
- A properly designed system can have 99% reliability (Todd Communications, 1992).
- No right-of-ways are required.
- Maintenance costs are low.

Disadvantages of a microwave system.

- Systems require high start-up costs.
- Transmissions are affected by weather, especially fog, rain, and lightning.
- Atmospheric disturbances can cause fading of signals.
- Equipment can fail and power outages can occur.
- Adding channels to a system is not easy.
- Thirty miles is the maximum distance between towers.
- An FCC license is required.
- A limited number of frequencies are available.
- Towers are almost always needed.
- Terrain extremes can increase equipment and tower costs.
- Special building permits may be needed.

Successful users of microwave systems. The following groups have reported on their successful microwave systems: (a) WHETS--The Washington Higher Education Telecommunication System, Washington State University (Nelson, Cvancara & Peters, 1989; Oaks, 1986); (b) TWIT--Two-Way Instructional Television at Morning Sun, Iowa (Nelson, 1985); (c) TIE--Televised Interactive Education Eastern Iowa Community College District (Kabat & Friedel, 1990, Wallin, 1990); (d) TAGER--Texas

Association for Graduate Education and Research at Dallas-Ft Worth, University of Texas at Dallas (Hart, 1986); (e) KTS--Kirkwood Telecommunications System at Kirkwood Community College, Cedar Rapids, Iowa (Hart, 1986; Hudspeth & Brey, 1986); (f) KIDS--Knowledge Interactive Distribution System, Minnesota (Descy, 1991).

General costs for microwave systems. The estimated costs for a duplex microwave system include $40,000-$65,000, plus towers, which range from $25,000-$75,000 each. Short haul systems may cost $35,000, plus towers, which range from $5,000-$50,000.

Maintenance costs average three to five percent of the system cost per year (Kitchen & Kitchen, 1988; National School Board Association, 1989; U.S. Congress, 1989). These costs include equipment service and repair and monthly maintenance fees.

Compressed Video Systems

Compressed video is a name routinely, and somewhat incorrectly, used to refer to digital video, audio, and data signals that are processed to reduce the amount of information in order to minimize the bandwidth required. It is important to note that compressed video refers to a technique for reducing the amount of information transmitted between two sites. A "compressed" signal can be carried by fiber or microwave, but since it has been compressed, traditional, inexpensive, and readily available copper wires can also be used. In other words, the installation of a compressed video system is often simplified because existing communications carriers can be used.

Compressed video is sent over fiber, satellite, microwave, and most often, high capacity digital service lines. In compressed video transmissions, redundant information is removed. For example, if the background does not change for several seconds, this information is sent only once and remains in memory. Video compression is achieved by sacrificing small amounts of color, motion, or resolution information. Although there is some loss of quality, compressed video is considered a viable alternative for many educational situations.

Equipment required for a compressed video system. Each system site must have (a) codec; (b) transmission line; and (c) interface unit. The codec converts the analog signal to digital format and compresses the signal. The channel service unit (CSU) is the interface between the end user and the telephone line. The CSU works in conjunction with the data service unit (DSU), which translates and controls the signal. This unit functions similarly to a modem (modulator/demodulator).

T channels refer to a band of high speed, high capacity circuits devised to carry digital voice, audio, and data signals. T1 facilities and DS1 signals are the technology most often used for compressed video systems. DS1 signals have bandwidth capability for compressed video only; they do not have the necessary bandwidth for full motion video as does DS3. T1 facilities are often regular copper telephone lines. DS1 transmission lines can be leased from telephone companies.

Frame speed. Compressed video is available at 30 frames per second at 384 kb/s and 1.544 Mb/s. The P x 64 standard of 30 fram~~es~~ per second is not the same 30 frames per second of full motion video. The P x 64 standard rates pixels per screen, while the National Television Standards Committee (NTSC) video signal does not have pixels. The P x 64 thirty frames per second means the picture is refreshed or updated every 30 seconds. Differences in picture quality can exist within this standard. Different vendors' codecs refresh different elements such as color, gray scale, or motion.

Advantages of a compressed video system.

- The equipment is easy to install and use and little training is required.
- Compressed video requires less bandwidth and therefore it costs less to transmit.
- Compressed video can have a price advantage over fiber or microwave in long distance

installations or systems in hostile terrain.

- Compressed video interfaces with existing systems and is easily upgradable (Todd Communications, 1992).

Disadvantages of a compressed video system.

- Systems have high start-up costs.
- Motion can become jerky.
- Color may be substandard and picture quality may be poor.
- There is dependence upon the lease-lines of the utility supplier.
- Compressed video systems do not transmit NTSC, full motion video.

Successful users of compressed video systems. The following groups have reported successful use of compressed video systems: (a) California State University Campus, Bakersfield (Ward, 1990); (b) V.E.I.N.--Video Education Interactive Network, Wyoming Center for Teaching and Learning at Laramie (Edwin, Owens & Rezabek, 1991); (c) Penn State (Phillips, 1987); (d) IVN--Interactive Video Network, North Dakota (Tykwinski & Poulin, 1991); (e) University of Minnesota (Kolomeychuk & Peltz, 1991).

Research relating to compressed video systems. The Applied Research Institute (cited in Keller, Staab & Stowe, 1989) found that (a) compression technologies have improved, (b) at the same time that signals have been further compressed and equipment costs have dropped, picture quality has remained relatively good, (c) compression devices can now digitize and blend (multiplex) signals so different kinds of information can be sent simultaneously, (d) the hardware and software are still expensive even though prices have decreased, (e) standards are emerging for compatibility among vendors, and (f) use of existing transmission lines make compressed video cost-effective.

A study conducted in Japan reported that compressed video had practical use for teaching at a distance in an interactive environment (Wakamatsu & Obi, 1990). Jurasek (1992) conducted a study of the effectiveness of Iowa State University classes taught using compressed video technology. Students displayed positive attitudes toward instruction. They adjusted rapidly to the compressed video technique and felt the convenience of learning remotely far outweighed the effects of any picture quality loss or technical problems.

General costs for a compressed video system. Compressed video systems range in cost from $20,000-$300,000 (Ostendorf, 1989a). A typical point-to-point system would cost approximately $100,000. For example, in North Dakota, the implementation costs for compressed video digital systems averaged $29,502 per school in comparison to analog fiber systems that averaged $60,706 per school (Hobbs, 1990).

Distance Education Classrooms

Classrooms for ITV are usually one of two types. The first type is a production studio, comparable to a television studio. Production studios require special lighting, a control room, and a crew. The second type of distance education facility is the electronic classroom. In this classroom, there is no control room; the technology is operated by the instructor. The classroom is both a television studio and a learning environment. The concept is to make the technology as transparent as possible and to make the teaching site appear to be a classroom, not a studio.

Characteristics

Various examples of distance education classrooms are discussed in the literature. The following are characteristics that are described as important considerations for planning for the installation of a distance education classroom.

Size. The classroom can be a conventional school room, which typically is about 25 feet x 35 feet. Converted classrooms can be used as long as acoustic, lighting, and other needs are met (Hudspeth & Brey, 1986). Hughes (1988) stated that a distance education classroom should be longer than it is wide.

Soundproofing. Soundproofing may be necessary to exclude exterior noise and to reduce classroom noise. Since sound can enter any-where air can enter, all holes and gaps in or between walls, floors, and overhead structures should be filled and sealed. Doors should be of solid construction and equipped with floor sweeps and weather stripping (Price, 1991). Windows should be double pane, if possible. Walls, floors, and ceilings should be sound resistant and constructed of dense materials such as concrete, solid masonry, or double layers of gypsum board (Hudspeth & Brey, 1986; Price, 1991).

Interior noise is generated by ventilation systems, fluorescent lights, television monitors, furniture, and other equipment. Ventilation systems should be run constantly at a low pressure, if possible. Systems that cycle on and off are very distracting and may require users to make constant audio adjustments. One way to test a potential distance education room for external and internal sound disturbances is to tape record the room when it is not in use. This tape will indicate outside noise disturbances and distractions from such things as ventilation and lights within the room.

Decor. Esthetic considerations for the classroom are fairly subjective. There are, however, particular items that do affect quality. Background color is particularly important for two-way video systems; there should be no complex patterns. All surface finishes should be non-glare. Materials such as chrome, glass, and shiny plastics create distracting glare that can be reflected onto monitor screens.

Lighting. Television is best viewed in normal light or in a slightly dimmed room. Natural light from windows and skylights is usually too bright for television monitors and can cause glare on screens. This can be controlled by draping or facing the monitors away from windows. However, television cameras require light to capture images and usually normal room lighting is adequate. For most purposes, common fluorescent light fixtures provide adequate and economical lighting. In the typical classroom, no special lighting is needed (Ostendorf, 1989a).

Classroom arrangement. Two-way video classrooms have few possible arrangements. Participants must be seated in relation to cameras and microphones, thus limiting the configuration of the room and the size of groups. Students should be seated so they can see each other and not have to turn to face the camera. Monitors should be placed in the front and possibly rear of the room so participants and instructors can maintain continuous visual contact (Fink & Tsujimura, 1991).

It is best to avoid placing monitors in a corner; this can diminish the importance of the material being presented and can create awkward viewing angles (Price, 1991). A viewer should not have to look up at an angle greater than 30 degrees (Price, 1991; Wood & Wylie, 1977). Looking upwards at a sharp angle for long periods can be tiring and uncomfortable. Monitors should be ceiling or wall mounted, four to six feet off the floor, if possible (Wood & Wylie, 1977). Remote site monitors should simulate the eye level of the instructor.

There should be comfortable seating for students and teacher (Minnesota State Department of Education, 1988). Individual comfort and appropriate style should be the highest priority. For extensive note taking or working with materials, learners should be provided with 20-24 inch wide tables.

Optimum class size is 15 to 25 students (Barker, 1989b; Bowman, 1986). By keeping classes small, students will interact more readily and use the system more fully (Lanier, 1986).

Teacher station. An important element of the system is the teacher station. There are various forms--table, desk, lectern, or special built podium. The teacher station always faces student seating. Putting this station on a riser increases visibility (Minnesota State Depart-ment of Education, 1990).

It is desirable for the teacher to have full control of cameras, lights, monitors, and various auxiliary equipment. If the instructor controls equipment, there is no need for extra technical personnel. This promotes an instructional format like the traditional classroom; therefore, teachers do not need to completely change teaching strategies (Currer, 1991; Greenwood & McDevitt, 1987; Minnesota State Department of Education, 1990).

Equipment. There should be standardization of equipment and installation, so in case of breakdowns, spare parts or items are interchangeable. Identical equipment makes it possible to verbally instruct someone on how to adjust equipment at remote sites, and with identical equipment, either site can serve as the origination site (Minnesota State Depart-ment of Education, 1988; Randall & Valdez, 1988).

- Microphones. Sound quality is the most problematic aspect of distance education systems; it is the most often reported technical complaint (Bowman, 1986; Descy, 1991; Fink & Tsujimura, 1991; Hobbs, 1990; Price, 1991). Each component of the audio system should be of highest quality (Ostendorf, 1989b; Price, 1991). Directional or cardioid microphones are best.

  Two problems commonly occur in sound systems, feedback and echo. Feedback is caused when microphones pick up sound from the speakers, producing overamplification and a piercing squeal from the speaker. Any time open microphones and open speakers are in the same room, feedback is a potential problem. This can be alleviated by separating the microphones and speakers.

  Echoes in the room are caused by sound reflections off smooth surfaces such as hard walls, floors, and ceilings. The shape of the room, the floor, ceiling, and walls all affect reflection. An acoustically treated room will not have echoes. To reduce echoes, acoustical ceiling tile and wall covering should be considered. Carpet is the best and least expensive sound absorber to improve acoustics in distance education classrooms (Hughes, 1988; Minnesota State Department of Education, 1988; Price, 1991). Television does not add to acousti-cal difficulties already existing in a room, but it does make them more acute. Acoustical problems in the class can negatively impact on learning (Smith, 1961).

- Cameras. Most interactive classrooms have three cameras. One is pointed at the students, the second at the teacher, and the third is at the desk or above the instructor, focused on graphic materials (Barker, 1989b; Bowman, 1986; Currer, 1991; Lanier, 1986; Minnesota State Department of Education, 1990; Nelson, Cvancara & Peters, 1989; Oaks, 1986). Some classroom systems have a fourth camera pointed at students (Fink & Tsujimura, 1991).

  Remote zoom and auto focus controls for cameras are recommended (Hughes, 1988; Minnesota State Department of Education, 1988; Oaks, 1986). Remote tilting and panning can also be added as extra features.

- Monitors. Monitors let the instructor and origination site students view students at the remote site. Monitors also let the instructor view what is being transmitted. Monitors at the remote site show what is being transmitted from the origination site.

  Most systems use 21-25 inch monitors (Barker, 1989b; Minnesota State Department of Education, 1988; Smith, 1961). Others use large screen projectors (Fink & Tsujimura, 1991; Greenwood & McDevitt, 1987). Some systems use a split screen to present the view from two cameras. Hughes (1988) reported that the split screen makes remote sites even smaller and seemingly more remote. He suggested using an additional 25 inch monitor rather than splitting the screen.

- Visual presenter. This device functions like an overhead projector. It is located at the teacher station, normally to the right of the instructor. A color camera in the device projects photographs, charts, maps, and three dimensional objects. The camera has the ability to zoom in on the platform where materials are placed and functions similarly to the overhead camera.

- Telephone. A telephone provides for alternative communication in case of emergency or equipment failure and allows for a direct link to the remote site (Minnesota State Department of Education, 1988; Randall & Valdez, 1988). It also allows for student/teacher one-on-one, semiprivate/private conversations.

- Facsimile machine. A facsimile transmits printed copy from classroom to classroom quickly. It can be used to supply immediate feedback for tests and corrected assignments (Descy, 1991; Minnesota State Department of Education, 1988). A facsimile may not be necessary if there is a dependable delivery service or a traveling teacher or administrator.

- Videocassette recorder (VCR). The VCR is used to record class sessions. This recording can be used by the student who has been absent, as a backup in case of technical difficulty, to provide a record of distracting student behavior, or so that the instructor can review for self-critique (Minnesota State Department of Education, 1988; Randall & Valdez, 1988). Special class sessions can be recorded for use in the future, also.

- Auxiliary equipment. In-class presenta-tions may require the use of a videodisk player, a videocassette player, a tape recorder, or a record player. This equipment can be located in the room on a cart and plugged into the system as an auxiliary input. Films and slides may also be shown as an in-class presentation by projecting the film or slides onto a projection screen and focusing either the teacher, student, or visual presenter camera on the screen. If there are many slide and film presentations planned, slide/film to video converters should be purchased.

- Computers. Use of computers as an auxiliary input requires special equip-ment. Computer monitors have different resolution capabilities and different scan rates than television monitors. Special equipment is needed to interface the two types of video. Output from high resolution computers must be converted down to the NTSC video standard, or multiscan monitors must be used.

METHODOLOGY

This cost analysis identified costs required to design, build, and install a distance education system using fiber, microwave, and compressed video. Cost analysis was defined by Perraton (1982) as the process used to discover all the costs involved in a particular activity. Adams, Hankins, and Schroeder (1978) defined cost analysis as any manipulation of cost data that provides relevant information for those who make decisions. A common method is simply "a direct comparison method between or among the costs of specific decision alternatives, e.g., a make or buy decision" (p. 24).

Data Collection

Data were collected using face-to-face, telephone, and written interviews. Questions were designed to determine the total costs for establishing a distance education system. Interviews were open-ended to offer flexibility and opportunity to pursue additional information. Reliability was built into the interview process by the use of repeated questions, rephrased questions, and follow-up questions. Also, interview questions were asked of more than one source.

Procedures

The first activity of this project was to obtain general information from the literature, consultants, telecommunications specialists, governmental offices (federal and state), and vendors. Next, specific questions were prepared. These questions were designed to identify hardware components essential to transmit and receive audio and video signals between two sites.

Technical experts who had experience with the transmission systems provided valid cost information. Also identified were vendors and consultants who had experience with distance education classroom equipment (Appendix).

Six hypothetical pairs of sites of varying distances from one another were chosen. Vendors were identified to provide estimates about costs about transmission media.

For the classroom equipment phase of this study, technical experts aided in the identification of designs, equipment items, and installation procedures. This process resulted in a classroom design and equipment list. Vendor catalogs and vendor quotations were used to obtain equipment prices.

RESULTS

Costs are summarized and categorized in two sections. The first section deals with the costs of fiber, microwave, and compressed video systems. The second section deals with the interactive distance education classroom costs.

Costs of Fiber, Microwave, and Compressed Video Systems

When setting up a distance education transmission system, specific elements define costs for each technology. These elements usually fall into three areas--feasibility and planning, system design, and purchase and installation.

Fiber Systems

Fiber optic systems consist of cables that transmit light signals rather than electrical signals. Purchasing and installing fiber systems is a complex process. Nearly 95 percent of the interactive television systems designed today use fiber optics in combination with coaxial cables.

Fiber systems can be analog or digital. While the fiber is identical, the termination equip-ment is different. Digital fiber provides higher quality at a distance. Analog is more appropriate for short distances. Analog fiber picks up noise over distances; digital fiber does not. An analog system is cost-effective for distances under 30 miles, but the costs for an analog fiber system over 30 miles may be prohibitive since a repeater (booster) is needed every 30 miles (at a cost of $15,000-$18,000). A building protecting each repeater is also required (at a cost of $1,500).

What does it cost to put into place a point-to-point fiber system? The total cost of a fiber system depends on the fiber type, total system design, and location. T. Crandall, General Services, indicated that fiber for state of Iowa projects cost approximately $12,000 per mile, based on 10 miles (personal communication, June 4, 1992). H. Sarrazin, Tele-Systems, concurred that fiber costs $10,000-$15,000 per mile (personal communication, May 21, 1992), and W. Fackler, Spectra Associates, generalized costs of fiber at $15,000-$20,000 per mile (personal communi-cation, May 29, 1992). D. Takkunen, Todd Communications, estimated fiber costs at $20,000 per mile (personal communication, April 27, 1992). All of these estimates were strictly for labor and fiber; end point equipment and right-of-way expenses have not been included in the totals above. In metropolitan areas where there are right-of-way expenses and higher costs for labor, installation rates may be as high as $70,000 per mile.

One vendor supplied budgetary cost data for fiber systems at approximately $18,000-$22,000 per mile (Appendix). T. Crandall, General Services, stated Iowa schools would likely pay somewhere between $12,000 and the $22,000 per mile (personal communication June 4, 1992).

What are the major cost considerations?

- Consultation. Charges for consultants vary greatly, with costs dependent upon detail, distance, and location. Services include (a) feasibility studies, (b) route surveys, (c) coordinate specifications, (d) right-of-way checks, (e) and route designs with drawings. In a route design, the entire distance is mapped. In a city, the map would be more detailed and would show underground cables, gas lines, and electric cables. Also included in some consultation fees are costs for staking the route, supervising the construction, and crew scheduling .

  Consulting services average $5,000-$15,000. At engineering companies, consulting costs are charged at the engineering rate of $50 per hour. In one cost study, consulting costs range from $3,000-$3,500 for rural areas to $7,500 for urban areas.

- Construction/materials. The MWR cost study identified construction and material costs (Appendix D). Labor construction costs ranged from $0.97 per foot to $1.55 per foot depending upon distance. Construction costs differ between rural and urban loca-tions. Urban areas require more field work, engineer work, concrete work, and easement attainment. The costs listed in Appendix D are for suburban locations with various open areas, not downtown metropolitan areas. A downtown urban area requires additional concrete work costing $10 per foot or more.

  Material costs are estimated to be $9,672 for rural construction and $15,712 per mile for urban construction. Material costs include fiber, manholes, warning tape, warning signs, and splices. In urban areas, duct costs are also added, and additional splicing and manhole costs are required.

- Easements. If construction crosses road-ways or railroads, an application usually must be filed to obtain an easement right-of-way. Most easements are obtained as public right-of-ways by formal applica-tion to the city, county, or state entity. If a public easement is obtained, a license is needed to place the cable in this right-of-way. Cities often charge approximately $1 per foot per year for easements. Other entities typically charge a percent of revenues for easements. When crossing private land, it may be necessary to pay for easement rights to the private individual.

- Terminal equipment. Digital end point equipment varies in price according to speed of transmission and capacity. Digital end equipment is usually one unit that functions as the codec, laser trans-mitter, optical receiver, and multiplexor/ demultiplexor (MUX/DEMUX). Equip-ment cost estimates range from $25,000-$57,000, including installation. Digital terminal equipment, connectors, and instal-lation of this equipment costs approximately $70,000. Analog end point equipment costs $6,000. Costs for leasing fiber usually include the costs for all equipment except for the device that converts the video signals generated in the distance education classroom into signals that can be transmitted through the fiber. This device costs approximately $6000 - $8000.

Microwave Systems

Microwave signals are transmitted through the air electromagnetically. Microwaves can carry full motion video. The placement of towers, equipment configurations, federal regulations, and frequency specifications necessitate techni-cal assistance and custom-made bids.

For a short distance, point-to-point system between two schools, microwave would be an appropriate choice. Microwave systems are easy to install, especially if transmitters are placed on buildings.

Microwave signals can be analog or digital. Analog is less expensive since equipment is not needed to create digital signals. Digital costs are decreasing, but many organizations continue to utilize analog systems. Most companies only install new analog microwave systems to be compatible with previously constructed analog systems. When constructing an entirely new system, digital microwave is generally used because it provides higher quality. Analog is affected by weather and atmospheric conditions that can cause fading, which produces noise and creates a hiss on the line.

What does it cost to install a microwave system?

The average cost to construct a microwave system covering a short distance is $40,000. Long-haul, one-hop systems over 8-15 miles can cost $150,000-$250,000. The use of repeater towers adds expenses for additional electronics, path studies, installation costs, and tower costs. Each repeater tower adds approximately $90,000 in equipment costs and $20,000-$35,000 in tower construction costs.

What are major cost considerations?

- Consultation. Services include (a) path profile to check for obstructions; (b) frequency coordinates to find other frequencies that might interfere; (c) path analysis to determine how much power is required; (d) completion of the FCC application; and (e) tower specifications to note items such as ice and wind load.

  Consulting services cost $2,000-$4,000, with an additional $2,000 for tower specifications. A one-hop path profile/ coordination usually costs about $1,500.

- Tower construction. Besides distance, tower height is dependent upon obstructions, elevation above sea level, and earth curvature. To transmit 20 miles, the antenna must be at least 150-200 feet on both ends. The 200-foot tower is average in Iowa. Towers over farm land can be fairly short, but any trees, buildings, or grain elevators in the path will increase the height requirement.

  A 20-foot tower is the minimum height for a transmitter. In order to clear trees, a 50-60-foot height is normally required. To place a dish on a building, the building must be high enough to clear trees and obstructions. Antenna extensions attach to a wall and extend beyond the building roof. A 20-foot tower in Iowa is generally a building or side-mount type and would cost approximately $5,000. An antenna on top of a two-story school building can send signals only a short distance.

  A 100-foot tower costs approximately $20,000. A 200-foot tower costs approximately $30,000 and a 300-foot tower costs approximately $35,000. Construction costs are higher for self-supporting towers, but less land is required since no guy wires are needed. A 200-foot, self-supporting tower costs approximately $200,000. A short, light weight tower for a short distance transmissions may cost as little as $2,000-$3,000. A heavier tower that attaches to the side of a building and extends up to 100 feet will cost about $5,000.

- Land. Land is needed for the tower site. A 200-foot tower requires two acres of land. It is sometimes desirable to lease land if possible. A land lease will usually cost $500-$800 a year in rural areas and as high as $5,000-$6,000 per year in urban areas.

- Equipment. The following equipment is needed at both ends of the system--transmitters, receivers, antennas, hardware connections. This equipment costs on average $45,000 at each end for long haul systems and $11,000 per end for short haul distances.

- Building. It is often necessary to construct a building to house the electronics at each tower site.

Building construction is approximately $1,500.

- Connections to the school. The tower should be located within a mile of the school. If towers can not be located near the school, short haul systems are required to get from the tower to the school. Coaxial cable used to connect the tower to the school costs about $5,000-$6,000 per mile, and an amplifier is needed every 2,000 feet ($500 each). At the school, the cable is hooked to a translator channel box for television reception, or to a VCR connection.

- Installation and testing. Before buying a microwave system, it is advantageous to place equipment on trucks and transmit from the point-to-point locations to verify that there is no interference. Installation and testing of equipment and systems cost up to $15,000-$30,000 per tower location.

- FCC application. A completed FCC application form #402 is required. The application fee is $155. Multiple hops require more than one license. Noncommercial educational broadcasts are exempt from charges (Code of Federal Regulations, 1991, §1.1112 (c)). A letter to the FCC would be necessary to request a fee exemption. The FCC requires that frequency coordinations must be completed by microwave technical experts, at a cost of approximately $1,000 to $1,500.

- Long and short haul systems. The maximum distance between towers is about 30 miles. Any distance over 30 miles would require repeater towers to boost and retransmit signals. Distances closer to the 30 mile limit require higher towers, more powerful transmitters, and larger antennas. Each repeater tower needs two sets of equipment, pointed each direction and adds approximately $100,000 to the cost of the system, plus additional installation and testing costs. Short haul systems can be purchased for as little as $15,000 to $20,000 per site.

Compressed Video Systems

As used here, compressed refers to digital video, audio, and data signals that are processed to reduce the amount of information required for trans-mission. This process reduces the bandwidth requirement. Compressed signals can be sent using any transmission method. Compressed video systems do not transmit full motion video, but do allow users to economically transmit signals on smaller bandwidths.

What does a compressed video system cost?

Equipment is needed to compress signals and change signals from analog to digital. This equipment costs approximately $36,000-$38,000 per site.

- Consultation. These services are often included in the total cost of vendor's packages. Design coordinators provide input about the equipment needed for particular classrooms.

- Equipment. Transmission equipment con-sists of a codec, interface, and a leased transmission line. Codecs average $36,000. CSU/DSUs cost approximately $1,700. Transmission line lease rates vary from $5,000-$20,000 a year, depending on the vendor and the distance.

- Installation. Charges for installing codec equipment are often included in the codec's purchase price, but some vendors charge as much as $1,500 for this service.

- Upgrades. Most vendors now have codecs that can be upgraded by updating their software. This is an essential because this technology is changing so rapidly. These upgrades cost $8,000-$15,000.

- Transmission line lease options. When leasing services, there is normally a one time connection charge of approximately $1,400; this charge is not related to distance. Lease rates vary considerably. The longer the distance, the less per mile per month. Year lease rates range from

$5,000-$20,000 for distances of 3 to 75 miles. Most schools apply for and receive FCC-1 tariff rates. If the origination and receive sites are not in the same Local Access Transport Area (LATA), contacts must be made with the local carrier who will then make arragements with the distant site's carrier.

It is possible to lease terminal equipment (codecs). The list cost is multiplied by a cost factor to arrive at the monthly charge. A $36,000 codec leases for $1,136 per month, or $13,632 a year, based on a 36-month contract. Shorter contracts cost more per month. For a 12-month lease, the monthly charge averages $2,800 (or $33,600 per year).

Other Results

How do the costs vary for distances from 3 miles to 75 miles?

Transmission using fiber and microwave are directly affected by distance. Fiber is affected the most dramatically. The costs per mile are very high and each additional mile can add $12,000-$20,000 to the cost of a system.

Microwave costs are also affected by distance. The longer the distance, the higher the tower, and the larger the antenna dish needed. A 6-foot dish is $1,500, compared to a 12-foot dish which costs approximately $6,000. Every increment of 20-30 miles requires a new repeater tower with two sets of electronics. Each repeater tower can add $90,000-$120,000 for equipment, $20,000-$35,000 for tower construc-tion, and approximately $25,000 for installa-tion and testing. Path studies for each additional hop cost $1,000-$1,500.

Compressed video systems are the least affected by distance. Most of the cost of a system is in the codec equipment at the end points. Compressed video systems are fairly constant in cost.

What are the recurring and maintenance costs?

Transmission equipment is usually quite reliable. However, service and maintenance are important considerations for these systems. Technology does not always work and environmental circumstances may necessitate costly repairs. Maintenance contracts should state how readily the vendor is expected to provide service.

Fiber. Fiber equipment is reliable and needs few repairs. Replacement of a laser may cost $2,000 to $4,000, but laser failure is not common. Maintenance contracts for end point equipment are about one to two percent of the purchase price per month. This amount averages $3,300-$7,600 per year.

Microwave. Circumstances that require maintenance on microwave systems are wind damage, ice load, electrical storms, and electronic equipment failure. Maintenance contracts vary, and range between one to ten percent of the system's purchase price.

Compressed video. Maintenance contracts range from three to seven percent of the purchase cost. A recurring expense is the lease cost of the transmission line.

What are the characteristics, advantages, and disadvantages of the three transmission technologies?

Fiber. Fiber is superior in signal quality and bandwidth capacities. Fiber is unaffected by the environment and needs little maintenance. Fiber costs per channel capacity are cost-effective. The disadvantages of fiber are high initial cost and the complexity of installation.

Microwave. Microwave transmission for short distances is cost-effective. Short distances use inexpensive towers and relatively low cost transmission equipment.

One disadvantage of microwave is that it is an aging technology, and the majority of frequencies in metropolitan areas have been assigned. Distance education systems require a great deal of channel capacity. In the last five years, the increasing use of cellular phones has decreased the number of available frequencies. For short haul microwave systems (which utilize higher frequencies), there are more frequencies available.

In certain areas, microwave may not be feasible because of the terrain. Microwaves are affected by weather conditions, and some find FCC licensing and adherence to regulations restrictive.

Compressed video. Compressed video is easy to install and is relatively inexpensive as compared to the other systems. For educational purposes, compressed video may technically not be the best, but it is the easiest and often the least expensive to install. Since compressed video does not transmit full motion, images appear jerky at times. However, research data indicate that for most distance education applications, the quality is quite acceptable.

Distance Education Classroom Costs

This section presents the costs for an interactive distance education classroom. Technical experts were interviewed about classroom design, production equipment requirements, types, and specifications.

What does it cost to equip a distance education interactive classroom?

Equipment for the classroom designed for this monograph cost $39,539 for the state-of-the-art classroom, and $21,988 for a basic classroom. The Appendixes also include equipment specifications and cost estimates.

Consulting. Private design consultants charge approximately $5,000 to develop a plan for a complete system. The Media Resources Center at Iowa State University charges $250 for an initial visit and $250 a day plus expenses for additional visits. Installation assistance costs are $30 per hour per person. Consultation costs for installing a complete classroom would average about $4,000.

Room Treatment. Most classrooms are easily adapted for use as distance education classrooms. A room is adequate if there is sufficient lighting for the cameras, no extensive glare problems, adequate wiring, and adequate space. Although most rooms have adequate wiring for distance education equipment, it is necessary to determine the power requirements for all equipment. Technicians can then verify that there are sufficient outlets and amperage levels. General rules to follow include (a) unless it is a special circuit, do not put more than five items to a line, and (b) isolate computers on separate lines.

An acoustically treated room prevents many problems associated with audio systems. Acoustic treatment includes fiber ceiling tiles, carpet, drapes, or fabric covered panels. A room can be acoustically treated for $3,000-$4,000.

Most classroom production equipment is reliable and does not require repair, but replacement costs for broken microphones or cameras may be needed.

Classroom Design. Examples of distance education classrooms are found in the Appendix. The key to the design is the equipment list. Costs reflect current catalog list prices. School systems can expect a 30 percent discount from vendors.

Equipment Descriptions. The size of the representative classroom in the design is 28 feet by 30 feet and will accommodate at least 24 students. Tables are 24 inches x 96 inches, each seating four students. Two monitors and two microphones are located on each table. The instructor desk can be placed upon a riser to improve visibility.

- Cameras. CCD cameras (charged coupled device) use a "chip" in the pick-up device rather than a conventional tube. The chip is more durable and requires less light. Included in the camera list price are a pan/tilt controller, a zoom lens, and AC adapters. The pan/tilt controller and zoom lens can be eliminated from the cameras pointed at students, but are necessary on the instructor camera. A 2-chip camera produces a higher quality signal in lower light. However, a 1-chip camera is acceptable for most applications. Three-chip, studio quality cameras can be used, but are more expensive.

  The visual presenter (document camera) features a single chip, CCD color camera with manual focus and zoom control. An overhead camera can be ceiling mounted as a substitute for the presenter. However, the visual presenter is easier to install and use.

- Monitors. Twenty-five inch or larger color monitors should be used at the origination and remote sites to display program output. At the origination site, a monitor should also display the remote students. Three 7 inch color monitors are used at the teacher station. One monitor displays the remote site students, one the program output, and one continually shows the document camera's output so the instructor can align materials before sending the signal from this device. The 13 inch color monitors on student tables allow for display of the program video. Individual student monitors are recommended because (a) larger projection screens lose resolution and have a degraded image, (b) the closer the distance, the better the visibility and legibility, and (c) if one monitor of the system malfunctions others are available. At the remote site, an additional monitor is sometimes added in a teacher's or principal's office for supervisory purposes.

  Multiscan monitors automatically accept inputs from any video or personal computer source. If there is a need to transmit computer data, then monitors must be multiscan.

- Audio systems. Although the ideal dis-tance education classroom would have a microphone for each person, two people per microphone is adequate. The best microphones for the distance education classroom are cardioid. Cardioid microphones pick up sounds better from the front than the back. Cardioid microphones are used where ambient noise should be suppressed.

  Student microphones should be low profile, wired, and voice activated. Low profile microphones require minimal installation. The teacher microphone should be a wireless or wired lapel-type.

  Push-to-talk microphones are not recom-mended. They require an action on the part of the student and are not "user friendly." The clicking of the button is also a noise in the system. Frequent repairs are need when this type of microphone is used.

- Media controller. A switcher lets the instructor select and control multiple video outputs, and a remote control manipulates cameras. In a state-of-the-art classroom, a room controller functions as a switcher, controls the local and remote sites, and controls camera functions. It can also have diagnostic functions.

- Rack mount. The rack mount shelving unit fits under or beside the desk. Adapter kits need to be added to shelve individual units ($30-$150 each unit).

- Video distribution. A video distribution amplifier is needed if many monitors are used. This unit divides and amplifies video signals.

SUMMARY

This study determined the costs for creating an interactive, two-way distance education system using fiber, microwave, and compressed video. Transmission costs were compared for various distances. The study also described costs for equipping and installing a distance education classroom.

Each medium was found to be unique. When selecting a medium, some compromises may be required; budget constraints or environmental factors may force trade-offs. Significant elements to consider are the content of material communicated, the quality of transmission desired, the cost, and the ease of system use.

Fiber systems were found to be more complex than the other media. Microwave and compressed video systems had elements that were comparable from system to system. It was most difficult to estimate costs for fiber systems. There are more cost variables to consider, and these variables are not consistent between applications.

If full motion video is necessary, microwave systems are viable alternatives for schools. Microwave systems are cost-effective and easy to install if the transmission distance is less than 10 miles. Microwave is also the least expensive option for short distances. Leasing microwave towers can decrease costs for two-hop systems, but leasing still requires a large investment.

Microwave transmissions can be affected by weather conditions. Adverse weather can also inflict damage on microwave equipment. Microwave frequencies are not always available, and geographic topography may limit microwave feasibility.

Compressed video systems offer the quickest and easiest solution for creating an ITV network between two schools. A compressed video system can be installed with little need for extensive construction. Most educators say they prefer a full motion system, but research indicates that compressed video is effective and satisfactory and that the picture quality of the compressed video technology is constantly improving. Most viewers do not object to small sacrifices of color, motion, or resolution. Successful users indicate that content takes precedence over image quality.

Concerning the three transmission systems, it was found that:

- Fiber was found to be most expensive and fiber systems were more complex than other media.
- Microwave for distances under 10 miles was a cost-effective way to connect two schools.
- The major costs were (a) system consulting and design, (b) materials, construction, and installation, (c) terminal end point equipment, and (d) maintenance contracts.
- Distance significantly affected the costs of fiber and microwave. Both became cost-prohibitive ways to connect two sites as distances increased.
- Compressed video system costs were the least affected by distance. Most of the costs for this technology were for compression/end-point equipment.
- Most experts recommended using digital technology, which offers superior quality.
- Fiber can be cost-effectively installed by schools short distances from each other.
- Urban fiber construction costs were greater than rural fiber construction costs.
- Microwave frequencies are not available in some cities.
- Leasing a building or tower for use as a repeater tower between two schools rather than constructing a tower decreased expenses.
- Leasing a repeater station required a large capital investment.
- There was variation in microwave repeater lease rates according to location.
- There was variation in land lease rates according to the location of microwave towers.
- Towers should be built as close to schools as possible.
- Installing and testing microwave systems was expensive.
- Long haul microwave systems were not cost-effective unless a repeater structure was leased

inexpensively, and dishes were put on buildings.

- One hop microwave costs (1 - 30 miles) increased as the distance increased--higher towers and more powerful transmitters were needed.
- Microwave systems were the most susceptible to malfunctions, because they were most affected by weather.
- Telephone companies charged more than utility companies for fiber leases.
- Metropolitan areas, generally, had access to less expensive fiber leases than rural areas.
- Cost per mile for lease rates for DS1 & DS3 decreased as distance increased.
- Lease rates for DS3 were 3 to 8 times the monthly lease rate of DS1.

Conclusions about the interactive distance education classroom were that:

- Usually classrooms do not have to be completely remodeled to be distance education classrooms.
- Basic equipment costs ranged from $25,000 - $30,000.
- Equipment was easily added or eliminated to fit budgets and needs.
- Packages of complete systems cost 30 to 70 percent more than the purchase of individual items.
- Maintenance is not a significant cost variable for classroom equipment.
- Transmission of computer generated signals significantly increased costs.
- There was variation in vendor's equipment packages in relation to capabilities, included options, and prices.

Conclusions

If full motion video is essential for interactive distance education, microwave is the most viable solution for shorter distances. Even though microwave systems are affected by weather, they still are effective for linking two schools. Digital fiber is the best choice as far as quality and capacity, but high costs tend to negate this advantage. Fiber is the most complex to install; this complexity contributes to higher costs. High costs make fiber too expensive for two school systems to install without some outside financial assistance. Leasing fiber is appropriate if fiber is in place.

If compressed video is deemed a satisfactory transmission method, overall it is the least expensive to install and is a viable solution, no matter the distance. Compressed video is a cost appropriate solution for longer distances. Both fiber and microwave systems are somewhat cost prohibitive for longer distances.

The standard classroom is easily adapted for use as a distance education classroom without significant remodeling costs. A distance education classroom can be equipped for less than $30,000.

Two-way, interactive television systems are expensive, complex and time-consuming to design, construct, and maintain. Once installed, however, they are neither difficult nor complex to use. With knowledgeable advice and sufficient planning, schools can have successful distance education programs. If the purpose of choosing an interactive system is to reach students and provide instruction, all three approaches can attain that goal on a fairly equal basis. The success of any delivery system, of course, depends upon the quality and usefulness of the content delivered and received, rather than upon the choice of equipment.

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TABLE

Table 1. Comparison of digital fiber, digital microwave, and DS1 compressed video costs

Distance	Transmission medium	Purchase[a] costs for two sites	End point[b] costs for two sites	Lease[c] for two sites	First year total costs[d] two sites	2nd year costs[e] for two sites	5 Year costs for two sites[d]	Average cost per year 5 year period
3 miles	Fiber, purchased	66,000	72,000		138,000		138,000	27,600
	Fiber, leased		12,000	36,000	48,000	33,000	180,000	36,000
	Microwave	35,000			35,000		35,000	7,000
	Compressed DS1		72,000	7,500	79,500	4,500	97,500	19,500
10 miles	Fiber, purchased	212,000	72,000		284,000		284,000	56,800
	Fiber, leased		12,000	38,000	50,000	35,000	190,000	38,000
	Microwave	41,000			41,000		41,000	8,200
	Compressed DS1		72,000	8,700	80,700	5,700	103,500	20,700
20 miles	Fiber, purchased	415,000	72,000		487,000		487,000	97,400
	Fiber, leased		12,000	41,000	53,000	38,000	205,000	41,000
	Microwave	166,000			166,000		166,000	33,200
	Compressed DS1		72,000	10,300	82,300	7,300	111,500	22,340
30 miles	Fiber, purchased	615,000	72,000		687,000		687,000	137,400
	Fiber, leased		12,000	48,000	60,000	45,000	240,000	48,000
	Microwave	213,000			213,000		213,000	42,600
	Compressed DS1		72,000	13,000	85,000	10,000	125,000	25,000
50 miles	Fiber, purchased	993,000	72,000		1,065,000		1,065,000	213,000
	Fiber, leased		12,000	54,000	66,000	51,000	270,000	54,000
	Microwave	357,000			357,000		357,000	71,400
	Compressed DS1		72,000	16,000	88,000	13,000	140,000	28,000
75 miles	Fiber, purchased	1,431,000	72,000		1,503,000		1,503,000	300,600
	Fiber, leased		12,000	76,000	88,000	73,000	380,000	76,000
	Microwave	493,000			493,000		493,000	98,600
	Compressed DS1		72,000	20,000	92,000	17,000	160,000	32,000

[a] Purchase costs refer to all construction, material, and equipment (not end point) costs involved in building the system.

[b] End point costs include transmission equipment, hardware, cables, and power supply, plus codecs which change analog signals to digital signals and compress the signal.

[c] This price reflects one time connection fee.

[d] No maintenance or operating costs are included for purchased systems; lease costs include maintenance and operating costs.

[e] One year lease rate for contract period of 60 months.

APPENDIX A- Considerations For Distance Education Systems

CONSIDERATIONS FOR SETTING UP A DISTANCE EDUCATION SYSTEM

Fiber System

1. FEASIBILITY STUDY. This is a planning stage. Specific options to consider are:
   - Service needs
   - Economic and technical aspects
   - Procuring easements from the railway or state, city or county
   - Contacting individuals currently utilizing fiber systems
   - Leasing from individual telephone companies, utility companies, cable companies, and large businesses
   - Researching all possible partnerships and funding sources
   - Growth requirements

2. SYSTEM DESIGN. This includes determining specifications, routing distances, and estimating costs. Specific decisions and concerns include:
   - Type of system - analog or digital
   - Transmission distance
   - Type of fiber - single mode or multimode, step index or graded index
   - Type of optical equipment - LED or ILD; PIN or APD
   - Modulation type and code format; wavelength
   - Path coordinates
   - Detail map of route
   - Easements for roadways and railroads
   - If leasing, negotiate contract with conditions on rates, maintenance, service priority, and time periods

3. PURCHASE AND INSTALL. This phase involves actually putting the fiber into the ground, tying the system together with terminal equipment, and testing the system. Specific concerns are:
   - Method of installation
   - Staking the route
   - Splices or connectors
   - Installing the fiber
   - Terminal equipment - cost and technical support
   - Initial check of the system to see if it works
   - Maintenance agreement/fees
   - Warranty
   - Maintenance support
   - Compatibility of end point equipment with classroom equipment

Microwave System

1. FEASIBILITY STUDY. This is the planning stage. The following are options to consider:
   - Service needs
   - Economical and technical aspects
   - Funding and financial planning
   - Contacting individuals currently utilizing microwave systems
   - Availability of frequencies or leasing facilities
   - Land topography and distance
   - Growth requirements
   - Availability of suitable sites for repeater stations

2. SYSTEM DESIGN. This includes determining specifications, locating points, and estimating costs. Specific decisions and concerns include:

- Type of system - analog or digital
- The distance and number of repeaters needed
- Selection of sites - must be line-of-sight with no obstructions as trees, or buildings
- Visual check of lease possibilities and obstructions
- Frequency band study to find other frequencies that might interfere
- Setting frequency
- Path profile to determine tower height and check for obstructions - use topographical map to determine elevations and plot points
- Tower specifications, e.g., wind and ice load
- Path calculations to determine equipment parameters/ configurations to meet performance requirements, e.g., antenna size, transmitter power output, receiver noise figure, required bandwidth
- Path survey to provide information vital to installation; review above calculations and specifications
- If leasing, negotiate contract with rates, maintenance, service priority, and time periods

3. PURCHASE AND INSTALL. This phase involves the actual construction of the tower, installing transmission and terminal equipment, and testing equipment. Specific decisions and concerns include:

- Acquiring land-lease or buy
- Availability of power and access road
- Getting FAA clearance
- Filing FCC application which includes an interference analysis and system design
- FCC tower construction application if over 200 feet
- Constructing the tower - consider time schedule
- Installing the transmission equipment; build protective building
- Beam alignment, equipment lineup and checkout
- Connections from tower to school
- Hooking up cable in classroom
- System warranty
- Maintenance agreement/fees
- Maintenance support

Compressed Video System

1. FEASIBILITY STUDY. This is the planning stage. The following are options to consider:

- Service needs
- Economic and technical aspects
- Possibilities for leasing the cable
- Cost-sharing between two sites
- Deciding if compressed video has the quality needed for the determined educational use
- Contacting individuals currently utilizing compressed video systems

2. SYSTEM DESIGN. This includes determining equipment specifications, estimating costs, and negotiating contracts. The following are specific decisions and concerns:
    - Transmission equipment (codec) - purchase or lease
    - Transmission rate - 112 kb/s, 384 kb/s, 1.544 Mb/s
    - Dial up or dedicated line
    - P x 64 standards for interoperability/proprietary standards
    - Full or fractional T lease

3. PURCHASE AND INSTALL.
    - Leasing T1 lines - negotiate rates, maintenance, service priority, time periods
    - Installing equipment - time schedule, costs
    - Technical support for installation equipment
    - Purchasing own classroom equipment or vendor video package
    - Compatibility of all equipment in system
    - Upgrading capabilities
    - Technical hardware and software service support
    - Warranty on equipment
    - Maintenance agreement/fees

APPENDIX B - Cost Estimates For Fiber Systems

FIBER OPTIC AND VIDEO EQUIPMENT INSTALLATION COSTS

FIBER OPTIC CABLE INSTALLATION COSTS

RURAL AREAS

				CONSULTATION COSTS						
DISTANCE, MI	CONSTRUCTION COST/FT	CONSTRUCTION COST/MI	CONSTR'N TECHNICAL	FIELD WORK	DRAFTING	ENGINEERING	OTHER	MATERIALS	TOTAL ESTIMATED COST/MILE	TOTAL ESTIMATED COSTS
3	$1.55	$8,184	$600	$850	$650	$1,000	$1,000	$9,672	$21,956	$65,868
10	$1.40	$7,392	$600	$850	$650	$1,000	$1,000	$9,672	$21,164	$211,640
20	$1.35	$7,128	$600	$800	$600	$950	$1,000	$9,672	$20,750	$415,000
30	$1.30	$6,864	$600	$800	$600	$950	$1,000	$9,672	$20,486	$614,580
50	$1.21	$6,389	$600	$750	$550	$900	$1,000	$9,672	$19,861	$993,040
75	$1.09	$5,755	$600	$700	$500	$850	$1,000	$9,672	$19,077	$1,430,790
100	$0.97	$5,122	$600	$700	$500	$850	$1,000	$9,672	$18,444	$1,844,360

CONSTRUCTION:	DIRECT BURY CABLE ALONG RURAL ROW BY PLOWING METHOD.
FIELD WORK:	SURVEYING, SKETCH PLANS.
DRAFTING:	CAD DRAWINGS OF PROPOSED INSTALLATION, AS-BUILT DRAWINGS.
TECHNICAL:	SPLICE AND TEST FIBER CABLE.
ENGINEERING:	ROUTE PLANNING, SUPERVISION OF CONSTRUCTION & TECHNICAL CREWS, SCHEDULING, SOME ROW ISSUES.
OTHER:	ROW ACQUISITION, LEGAL, ADMINISTRATION

MATERIALS:	CABLE:	$1.00/FT (12-F, SINGLEMODE, ARMORED)	$5,280
	MANHOLES:	3/MILE @ $700/EA	$2,100
	WARNING TAPE:	$0.05/FT	$264
	WARNING SIGNS:	1/500' @ $50/EA	$528
	SPLICING:	1 SPLICE/MILE @ $1000	$1,000
	MISC.		$500
	TOTAL		$9,672

FIBER OPTIC AND VIDEO EQUIPMENT INSTALLATION COSTS

URBAN AREAS				CONSULTATION COSTS						
DISTANCE, MI	CONSTRUCTION COST/FT	CONSTRUCTION COST/MI	CONSTR'N TECHNICAL	FIELD WORK	DRAFTING	ENGINEERING	OTHER	MATERIALS	TOTAL ESTIMATED COST/MILE	TOTAL ESTIMATED COSTS
1	$4.00	$21,120	$1,500	$1,800	$1,200	$2,500	$2,000	$15,712	$45,832	$45,832
5	$3.00	$15,840	$1,500	$1,800	$1,200	$2,500	$2,000	$15,712	$40,552	$202,760

CONSTRUCTION: PLACE 2" PVC DUCT @ 36" DEPTH; PULL CABLE THROUGH DUCT.

MATERIALS:	CABLE:	$1.00/FT (12-F, SINGLEMODE, ARMORED)	$5,280
	DUCT:	$0.50/FT (2" PVC)	$2,640
	MANHOLES:	5/MILE @ $700/EA	$3,500
	WARNING TAPE:	$0.05/FT	$264
	WARNING SIGNS:	1/500' @ $50/EA	$528
	SPLICING:	2 SPLICE/MILE @ $1000	$2,000
	MISC.		$1,500
	TOTAL		$15,712

END EQUIPMENT COSTS

	LOW		HIGH
EQUIPMENT COST/END:	$20,000	-	$50,000
INSTALLATION LABOR:	$5,000	-	$7,500
TOTAL ESTIMATED COSTS/END:	$25,000	-	$57,500

RANGE OF LOW - HIGH COSTS ARE DETERMINED BY INDUSTRY SPECIFICATIONS FOR SPECIFIC APPLICATION.

EQUIPMENT COSTS INCLUDE THE FOLLOWING:

- FIBER OPTIC MULTIPLEXER
- VIDEO CODEC EQUIPMENT
- RACKING HARDWARE
- FIBER TERMINATION HARDWARE
- CROSS CONNECT HARDWARE
- POWER SUPPLY SYSTEM
- MISCELLANEOUS CABLES

MAINTENANCE

ESTIMATED COSTS FOR MAINTENANCE AGREEMENT: $3300 - $7600/YEAR/END
(MAINTENANCE ON END EQUIPMENT)

APPENDIX C - Cost Estimates For Microwave Systems

DIGITAL RADIO SYSTEM
BASIC SYSTEM DUPLEX (Non-Protected)

SHORT HAUL 3 MILES

Equipment	Unit Price	Point A	Point B	Point C	System Total
Transmitter/Receiver w/ battery unit Antenna (included)	$10,300	1	1		$20,600
Cable	600	1	1		1,200
Audio Subcarrier	930	1	1		1,860
Tower	3,000	1	1		6,000
Path Study	1,000	1	1		2,000
Installation/Test	1,500	1	1		3,000
					$34,660

TERMS USED ON THE FOLLOWING PRICE LISTS ARE DEFINED BELOW:

Duplex refers to two-way communication.

Audio subcarrier refers to equipment to put audio on video channel.

Waveguide refers to antenna feed from antenna to transmitter.

Dehydrator refers to unit that keeps the waveguide moisture free.

Charger system refers to the battery power unit.

High power (TWT) and the auto power control refers to a power amplifier unit.

Non-Protected refers to equipment that does NOT supply automatic redundancy to cover system failures.

DIGITAL RADIO SYSTEM
BASIC SYSTEM DUPLEX (Non-Protected)

SHORT HAUL 10 MILES

Equipment	Unit Price	Point A	Point B	Point C	System Total
Transmitter/Receiver	$10,300	1	1		$20,600
Antenna 4 feet	1,500	1	1		3,000
Ant Cable	600	1	1		1,200
Tower	5,000	1	1		10,000
Path Study	1,000	1	1		2,000
Installation/Test	2,000	1	1		4,000
					$40,800

This system includes a heavier extension tower on the building roof that extends to at least 100 feet. The antenna size is increased over the 3 mile distance antenna adding an additional $1,500 to the cost.

DIGITAL RADIO SYSTEM (1 DS3 CAPACITY)
BASIC SYSTEM DUPLEX (Non-Protected)

SINGLE HOP 20 MILES

Equipment	Unit Price	Point A	Point B	Point C	System Total
Transmitter/Receiver	$32,720	1	1		$65,440
Antenna 8 foot	3,200	1	1		6,400
Waveguide (per foot)	13	250	250		6,500
Ant/WG Hardware	2,500	1	1		5,000
Dehydrator	756	1	1		1,512
Charger System 12 Amps	2,095	1	1		4,190
Batteries 96 Amp Hour	937	1	1		1,874
Tower 200 foot	20,000	1	1		40,000
Path Study	1,500				3,000
Installation/Test	16,000	1	1		32,000
					$165,916

DIGITAL RADIO SYSTEM (1 DS3 CAPACITY)
BASIC SYSTEM DUPLEX (Non-Protected)

SINGLE HOP 30 MILES

Equipment	Unit Price	Point A	Point B	Point C	System Total
Transmitter/Receiver	$32,720	1	1		$65,440
High Power (TWT)	4,000	1	1		8,000
Auto Power Control	1,550	1	1		3,100
Antenna 8 foot	3,200	1	1		6,400
Waveguide (per foot)	13	320	320		8,320
Ant/WG Hardware	2,554	1	1		5,108
Dehydrator	850	1	1		1,700
Charger System 25 Amps	3,700	1	1		7,400
Batteries 200 Amp Hour	1,500	1	1		3,000
Tower 300 foot	35,000	1	1		70,000
Path study	1,500				3,000
Installation/Test	16,000	1	1		32,000
					$213,468

DIGITAL RADIO SYSTEM (1 DS3 CAPACITY)
BASIC SYSTEM DUPLEX (Non-Protected)

TWO HOP 50 MILES
20 mile hop & 30 mile hop

Equipment	Unit Price	Point A	Point B	Point C	System Total
Transmitter/Receiver	$32,720	1	2	1	$130,800
High Power (TWT)	4,000		1	1	8,000
Auto Power Control (APC)	1,550		1	1	3,100
Antenna 6 foot	1,529	1	1		3,058
Antenna 8 foot	3,200		1	1	6,400
Waveguide (WG) per foot	13	320	640	320	16,000
Ant/WG Hardware	2,554	1	2	1	10,216
Dehydrator	756	1		1	1,512
Dehydrator	850		1		850
Charger System 12 Amps	2,095	1		1	4,190
Charger System 25 Amps	3,700		1		3,700
Batteries 96 Amp Hour	937	1		1	1,874
Batteries 200 Amp Hour	1,500		1		1,500
Tower 300 foot	35,000	1	1	1	105,000
Path study	1,500				4,500
Installation/Test	16,000	1		1	32,000
Installation/Test	24,000		1		24,000
					$356,700

DIGITAL RADIO SYSTEM (1 DS3 CAPACITY)
BASIC SYSTEM DUPLEX (Non-Protected)

FOUR HOP 75 MILES
25 mile hops

Equipment	Unit Price	Point A	Point B	Point C	Point D	System Total
Transmitter/Receiver	$32,720	1	2	2	1	$196,320
High Power (TWT)	4,000	1	1	1	1	16,000
Auto Power Control	1,550	1	1	1	1	6,200
Antenna 6 foot	1,529	1	2	2	1	9,174
Waveguide (WG)per foot	13	280	560	560	280	21,840
Ant/WG Hardware	2,700	1	2	2	1	16,200
Dehydrator	850	1	1	1	1	3,400
Charger System 12 Amps	2,095	1			1	4,190
Charger System 25 Amps	3,700		1	1		7,400
Batteries 96 Amp Hour	937	1			1	1,874
Batteries 200 Amp Hour	1,500		1	1		3,000
Tower 250 feet	30,000	1	1	1	1	120,000
Path Study	1,500					7,500
Installation/Test	16,000	1			1	32,000
Installation/Test	24,000		1	1		48,000
—						$493,098

APPENDIX D - Cost Estimates For Compressed Video Systems

(REV. April 20, 1992)

DISTANCE EDUCATION PROJECT

PRELIMINARY EQUIPMENT SPECIFICATIONS AND COST ESTIMATES

DESCRIPTION	MAKE	MODEL	QTY	UNIT	SUB
I. ORIGINATION SITE INSTRUCTOR CONSOLE					
PROG. SPEAKER	ANCHOR	AN-1000X	1	300.00	300.00
COMPUTER	APPLE MAC II SI	W/NU-VISTA BD	1	5000.00	5000.00
VISUAL PRESENTER	ELMO	EV-308/LU-308	1	2600.00	2600.00
SLIDE TO VIDEO TRANSFER	ELMO	TRV-35G	1	2300.00	2300.00
VHS PLAYER	PANASONIC	AG-1730	1	500.00	500.00
VHS RECORDER	PANASONIC	AG-1730	1	500.00	500.00
REMOTE SITE MONITOR	PANASONIC	PVM-8220 IN DUAL CONFIG	1	1200.00	1200.00
LAVALIERE MIC	SHURE	AMS 28	1	200.00	200.00
BACKUP WIRED MIC	SHURE	AMS 24	1	225.00	225.00
PREVIEW/PROGRAM MONITOR	SONY	PVM-8220 IN DUAL CONFIG	1	1200.00	1200.00
FURNITURE/RACKS	WINSTED		1	1000.00	1000.00
FAX MACHINE			1	800.00	800.00
II. ORIGINATION SITE DISTRIBUTION EQUIPMENT					
CODEC & CONTROLLER	?		1	35000.00	35000.00
AUDIO/VIDEO DIST.AMP	ESE		1	400.00	400.00
AUDIO/VIDEO SWITCHER	EXTRON OR TECH		1	1500.00	1500.00
REM.CONT. CAMERAS	PANASONIC	WV-D5100	2	2800.00	5600.00
AUDIO MIXER/ALC SYSTEM	SHURE	AMS 4000	1	1800.00	1800.00
III. ORIGINATION SITE STUDENT STATIONS					
SPEAKERS FOR SONY MON	ANCHOR	AN-1001	6	200.00	1200.00
FURNITURE	LUXOR	ATW-56	3	300.00	900.00
MICROPHONES	SHURE	AMS 22	8	200.00	1600.00
VIEWING MONITORS	SONY	PVM-2530	3	1500.00	4500.00
FURNITURE	TABLES		8	200.00	1600.00
IV. REMOTE SITE DISTRIBUTION EQUIPMENT					
CODEC & CONTROLLER			1	35000.00	35000.00
AUDIO/VIDEO DIST.AMP	ESE		1	400.00	400.00
AUDIO/VIDEO SWITCHER	EXTRON OR TECH		1	1500.00	1500.00
REM.CONT. CAMERAS	PANASONIC	WV-D5100	2	2800.00	5600.00
AUDIO MIXER/ALC SYSTEM	SHURE	AMS 4000	1	1800.00	1800.00
FURNITURE/RACKS —	WINSTED		1	1000.00	1000.00

PRELIMINARY EQUIPMENT REQUIREMENTS FOR THE COMPRESSED VIDEO CLASSROOM
DATA PRESENTED TO THE CLASSROOM STUDY COMMITTEE

(REV. April 20, 1992)

DESCRIPTION	MAKE	MODEL	QTY	UNIT	SUB
V. REMOTE SITE MONITOR CONSOLE					
FAX MACHINE	?		1	800.00	800.00
VISUAL PRESENTER	ELMO	EV-308/LU-308	1	2500.00	2500.00
VHS RECORDER	PANASONIC	AG-1730	1	500.00	500.00
BACKUP WIRED MIC	SHURE	AMS 28	1	200.00	200.00
PREVIEW/PROGRAM MONITOR	SONY	PVM-8220 IN DUAL CONFIG	1	1200.00	1200.00
REMOTE SITE MONITOR	SONY	PVM-8220 IN DUAL CONFIG	1	1200.00	1200.00
FURNITURE/RACKS	WINSTED		1	1000.00	1000.00
VI. REMOTE SITE STUDENT STATIONS					
FURNITURE	?		8	200.00	1600.00
SPEAKERS FOR SONY MON	ANCHOR	AN-1001	4	200.00	800.00
VIDEO CARTS	LUXOR	ATW-56	2	300.00	600.00
MICROPHONES	SHURE	AMS 22	8	200.00	1600.00
VIEWING MONITORS	SONY	PVM-2530	2	1500.00	3000.00
EQUIPMENT TOTAL					$ 130225.00
VII. INSTALLATION COSTS					
CABLING/CONDUIT	BELDEN & PANDUIT		1	2000.00	2000.00
LABOR					
VIII. LINE LEASING *					
IX. SYSTEM MAINTENANCE/SUPERVISION SUPPORT * MOVING AND SETUP COSTS ($250/DAY) TROUBLE CALLS FROM ISU TO SITE					

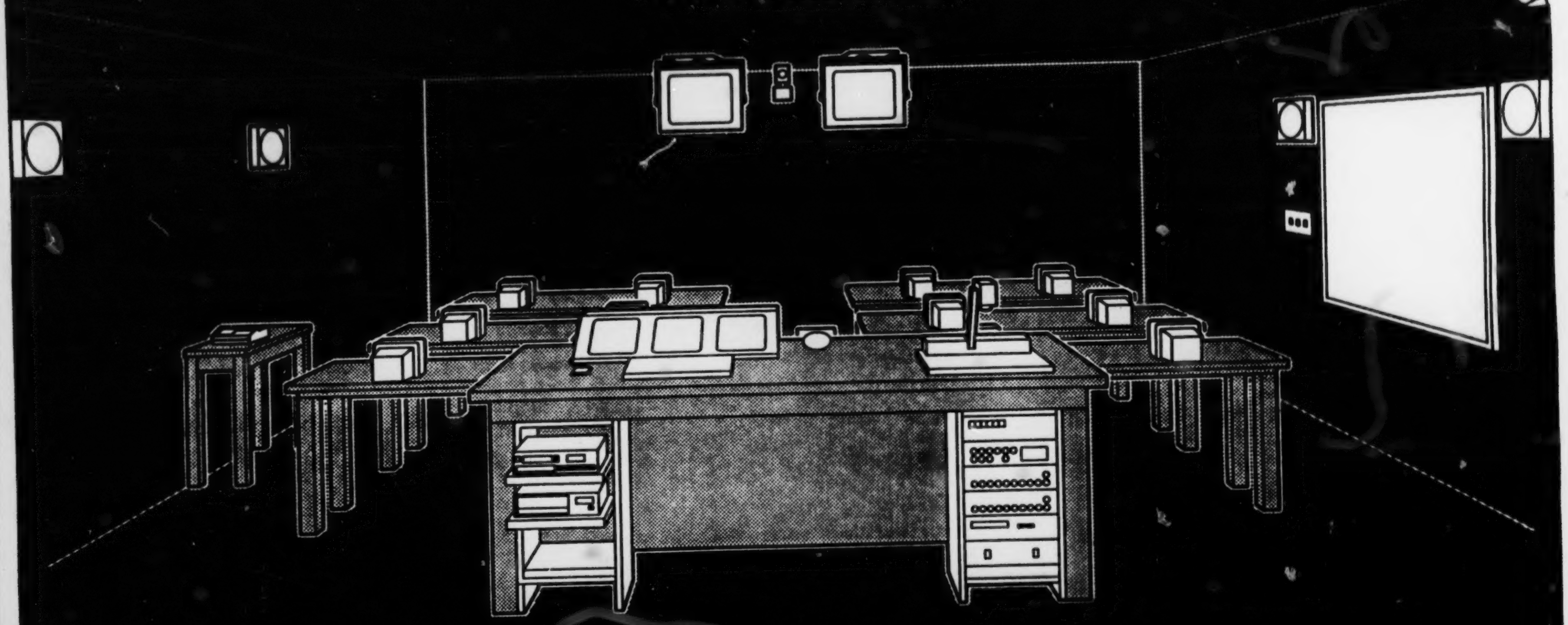
TOTALS	EQUIPMENT	$ 130225.00
	INSTALLATION	2000.00
	LINE LEASING	
	SYSTEM MAINTENANCE	
	TOTAL	

*ANNUAL ONGOING COSTS

APPENDIX E - Classroom Designs and Equipment Lists

Distance Learning Classroom - Teaching Site

View from Front



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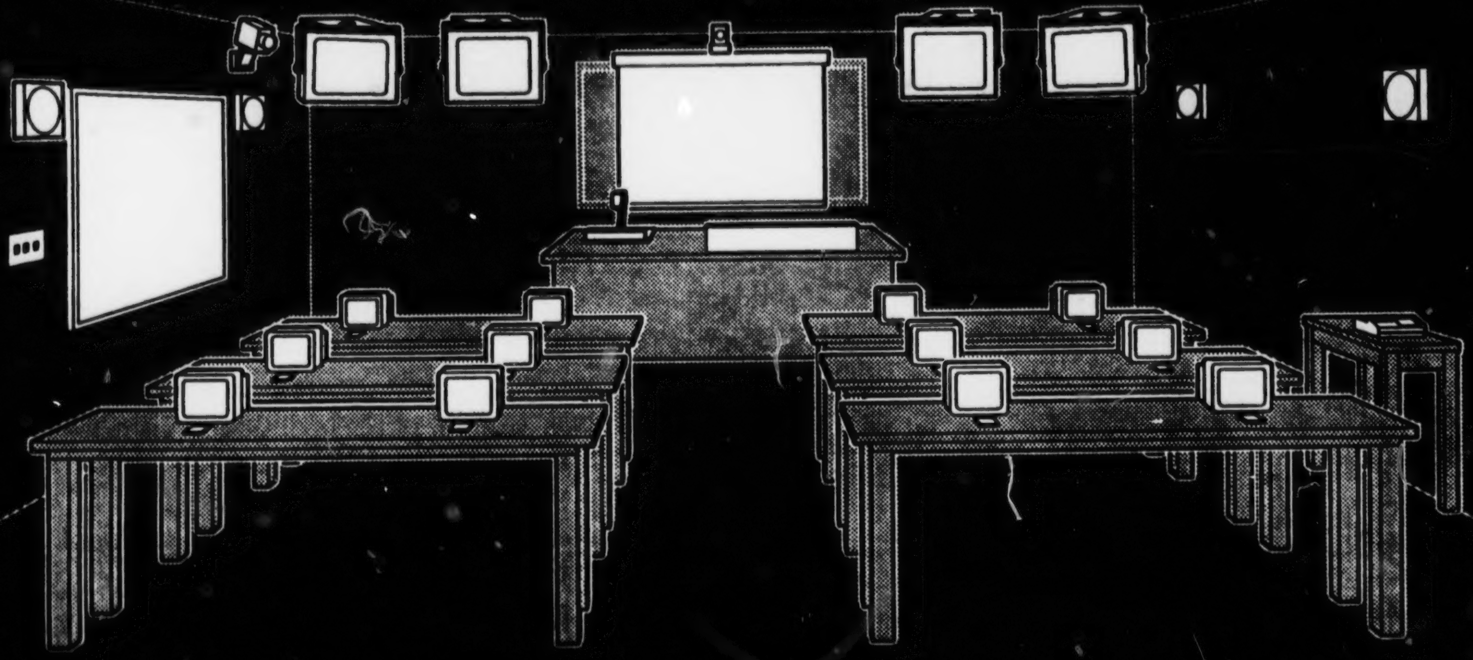
Distance Learning Classroom - Teaching Site

View from Rear



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Distance Education Classroom Equipment List
Origination Site

	Cameras	Quantity	Cost/Unit	Total Cost
A	Student camera (Panasonic WV-F70)	1	4295	4295
B	Student camera	1	4295	4295
C	Teacher camera	1	4295	4295
	Mounting brackets camera (Pan WV131P)	3	52	156
D	Visual presenter (Elmo EV-308)	1	3100	3100
	lightbar (Elmo LU-308)	1	300	300
	Monitors			
E	Monitor, outgoing 25"(Sony PVM2530)	2	1590	3180
F	Monitor, remote site 25"	2	1590	3180
G	Teacher monitor, remote site 25"	1	1590	1590
H	Teacher monitor, outgoing 25"	1	1590	1590
I	Monitor, individual student 12" (NEC PM1271A)	12	525	6300
J	Monitor, teacher 7" (Panasonic BT-S701N)	3	600	1800
	Mounting brackets monitor (ceiling) (Bretford Mfg TVM1)	6	221	1326
	Audio			
K	Speakers (Anchor AN1001)	4	163	652
K2	Teacher speaker (Anchor An1000X)	1	324	324
	Brackets (Anchor SB730)	4	43	172
L	Microphone, student (Shure AMS22)	12	210	2520
M	Microphone, teacher/wireless (Telex FMR-25TD)	1	600	600
	Teacher station			
N	Audio/Video control (Crestron)	1	6000	6000
O	Teacher control unit			
	Rack mount shelving (Winstead)	1	500	500
	Audio mixer (Shure AMS8000)	1	2800	2800
	Video distribution (Panasonic WJ300B)	2	290	580
	Power strip (Winstead 98700)	1	69	69
	Light/dimmer control (AMXM320)	1	675	675
P	VCR play/record (Panasonic AG1250)	2	350	700
Q	Facsimile (HP200)	1	1200	1200
			EQUIPMENT TOTAL	$52199
			-30%	$36539
	Supplies, cabling, wiring, connectors			3000
			TOTAL	$39539

	Quantity	Cost/Unit	Total Cost
Options for substitution [illegible]hancement			
3 chip camera (Panasonic WVF250)	1	7800	
Tripod for camera (ITE-T30)	1	295	
Large screen monitor 35" (Sony PVM5310)	1	2625	
Multiscan monitors 13" (Sony GVM-1300)	1	1495	
20" (Sony GVM-2000)	1	2300	
35" (Mitsubishi AM-3501R)	1	6900	
b&w teacher display monitors 4" (PVM 411)	1	1540	
Metal cart for monitor (Winstead R3353)	1	210	
Lavalier microphone (Shure AMS28)	1	235	
Room control panel (PenPal USWest)	1	7000	
Slide to video converter (Elmo TRV-35G)	1	3215	
Film to video converter (Elmo TRV-16G)	1	4290	
Echo canceller (Shure)	1	1640	
Time Base corrector (NOVA 700)	1	2290	
Computer interface (Micro 386 board)	1	2200	
NTSC Genlock card	1	2000	
Video Scan Converter PS 2	1	12995	
Video Scan Converter MAC	1	9995	
Table 96" x 24" Barron	1	606	
Table 18" x 60" Barron	1	483	
Table 60" x 24" Barron	1	518	
Porcelain board/metal board 72 x 48 $6.20 sq.ft.		149	

Acoustic treatment

Carpet	14.00 -16.00 sq. yd
Wall panels	5.60 sq. ft
Drapes	6.25 sq. ft

Riser

	Quantity	Cost/Unit	Total Cost
Materials 8' x 16'	1	160	
Materials 8' x 24'	1	240	
Labor	1	100	

Consultation: $1,250-$5,000

Installation: $2,500-$5,000

Basic Classroom
Distance Education Classroom Equipment List
Origination Site

	Cameras	Quantity	Cost/Unit	Total Cost
A	Student camera w/o pan, tilt, zoom	1	1720	1720
C	Teacher camera (Panasonic WVD5100)	1	2930	2930
	Mounting brackets camera (Pan WV131P)	2	52	104
	Teacher camera control	1	400	400
D	Visual presenter (Elmo EV-308)	1	3100	3100
	lightbar (Elmo-LU308)	1	300	300
	Monitors			
E	Monitor, outgoing 25" (Sony PVM2530)	1	1590	1590
F	Monitor, remote site 25"	1	1590	1590
G	Teacher monitor, Remote site 25"	1	1590	1590
H	Teacher monitor, Outgoing 25"	1	1590	1590
	Mounting brackets monitor (ceiling) (Bretford Mf TVM1)	4	221	884
J	Monitor, teacher 7" (Panasonic BT-S701N)	3	600	1800
	Audio			
K	Speakers (Anchor AN1001)	4	163	652
K 2	Teacher speaker (Anchor AN1000X)	1	324	324
	Brackets (Anchor SB730)	4	43	172
L	Microphone, student (AMS22)	12	210	2520
M	Microphone, teacher/lavalier (ShureAMS28)	1	235	235
	Teacher station			
N	Audio/Video control (Extron Model 8)	1	1495	1495
O	Teacher control unit			
	Rack mount shelf (Winstead)	1	500	500
	Video dist.(Panasonic WJ300B)	1	290	290
	Audio mixer (Shure AMS8000)	1	2800	2800
	Power strip (Winstead 98700)	1	69	69
P	VCR play/record (Panasonic AG1250)	2	350	700
Q	Facsimile (HP200)	1	1200	1200
			EQUIPMENT TOTAL	$28555
			- 30%	$19988
	Supplies, cabling, wiring, connectors		$2,000	$21988

Title:

The Effectiveness of Instructional Orienting Activities in Computer-Based Instruction

Author:

Richard F. Kenny

Introduction

The low cost and accessibility of the microcomputer has placed the power and flexibility of computing into the hands of the individual and opened a world of instructional possibilities. Among these are the capabilities offered by computer-based instruction (CBI) and of interactive multimedia such as computer-based interactive video (CBIV) in particular. While the use of CBI has been extolled for its capability to individualize instruction, interactive multimedia combines the power of the computer to support student interaction with the richness of the various audio and visual media.

According to Jonassen (1984), the major advantage of CBIV (and CBI in general) is that it is both adaptive and interactive. He defines adaptive as "the ability to adapt or adjust the presentation sequence, mode or sign type to meet a variety of instructional requirements..." and interactive as "that the program engages the learner to participate in a variety of ways that utilize learner responses..." (p.21). For Hannafin (1989), interactivity is more detailed, encompassing various instructional capabilities such as confirmation of response, learner control of pacing and lesson sequencing, inquiry (glossaries and libraries) and elaboration, techniques which allow learners to combine known with to-be-learned lesson information.

CBI, and especially interactive multimedia, while providing great flexibility, is not without problems. One is the potential for learner disorientation, the loss of one's sense of location or of the structure of the material. Navigation is the most commonly identified user problem in hypermedia (Jonassen, 1989, Kinzie & Berdel, 1990, Rezabek & Ragan, 1989). Learners can easily become lost and frustrated and may give up without acquiring any information from the program.

Another potential, and related, problem is cognitive overload. Jonassen (1989) also notes that the exponentially greater number of learning options available to learners places increased cognitive demands upon learners that they are often unable to fulfil. Tripp and Roby (1990) claim that disorientation leads to the expenditure of more mental effort to maintain a sense of orientation in the program which in turn reduces the mental resources available for learning.

A major challenge for teachers and instructional designers is to learn how to make effective use of the capabilities of such interactive learning systems to assist people to learn while avoiding the inherent problems. To guide research on the design of instructional prescriptions for CBI, the ROPES+ meta-model (Hooper & Hannafin, 1988, Hannafin & Rieber, 1989) was proposed. ROPES+ refers to Retrieval, Orientation, Presentation, Encoding, and Sequencing, "+" the influence of contextual factors. The "O" in ROPES+, then, refers to any form of "Orienting" activity which acts as "a mediator through which new information is presented to the learner" (Hannafin & Hughes, 1986, pg. 239). Included in this category are attention-gaining techniques, lesson objectives, pre-questions and advance organizers, which the authors consider to be "a variation of cognitive orienting ability" (Hannafin, 1987, p.48).

It is this category of orienting activities that may suggest methods for alleviating the problem of disorientation and cognitive overload in CBI. Tripp & Roby (1990), for instance, suggest that it has been the advance organizer which has traditionally been used as a device to orient students to content. However, other related instructional organizers might also be useful. Among these are the structured overview graphic organizer (Barron, 1969) and the pictorial graphic organizer (Hawk, McLeod & Jonassen, 1985), both derivatives of the advance organizer.

The purpose of this paper is to review the research literature pertaining to the use of instructional organizers and to provide a comparative analysis of their effectiveness with CBI. The review will first consider what evidence there is that any of these techniques have an effect on learning or retention. Second, it will examine the relevant research on the use of such orienting techniques with CBI. Third, the paper will compare two cognitive theories, Ausubel's (1963) Subsumption Theory and Wittrock's (1974) Generative Learning Hypothesis, to try to discern which most strongly predicts the effectiveness of these techniques. A third theory, Schema Theory (Anderson, 1977, Rumelhart & Ortony, 1977, Jonassen, 1989), and a related instructional orienting technique, the hypermap (Jonassen, 1989, Reynolds & Dansereau, 1990, Reynolds et al., 1991), are suggested as an alternative for further investigation.

Instructional Organizers

One of the earliest forms of instructional organizer was the advance organizer first proposed by David Ausubel (1960, 1963). The advance organizer is meant to facilitate the retention of meaningful verbal information. It is introduced in advance of the learning material itself and presented at a higher level of abstraction, generality and inclusiveness (Ausubel, 1963). Since its main function is to bridge the gap between the learner's cognitive structure and the material-to-be-learned, the advance organizer must be stated in terms familiar to the learner.

The graphic organizer was first advanced as a "structured overview" by Barron (1969) as a modification of the advance organizer and later renamed (e.g. Barron & Stone, 1974). It is a tree diagram which introduces the new vocabulary to be used in the material-to-be-learned and uses the spatial characteristics of diagrams to indicate the relationships and distances between key terms (Hawk, McLeod and Jonassen, 1985). While introduced as an advance organizer, the structured overview graphic organizer is unlike the former because it is written at the same level as the to-be-learned material and uses lines, arrows and spatial arrangement to depict text structure and relationships among key vocabulary (Alverman, 1981).

Hawk, McLeod and Jonassen (1985) further developed Barron's modification. Their form of organizer is a more pictorial, visual, or graphic presentation than the two previous organizers. Pictorial graphic organizers take one of two forms: participatory organizers, in which students participate in the completion of the organizer, and final form organizers, in which they do not.

Research on Advance Organizers

Ausubel's studies

Ausubel and his associates (Ausubel, 1960, Ausubel & Fitzgerald, 1961, 1962, Ausubel & Youssef, 1963), provided some of the most-cited research supporting the effectiveness of the technique. Ausubel (1960) tested the learning of undergraduates from a 2500 word passage on metallurgy and produced statistically significant results in favour of the group receiving an expository advance organizer. Ausubel & Fitzgerald (1961) compared the effects of an expository advance organizer and a comparative organizer on learning from a 2500 word passage on Buddhism. The comparative organizer group significantly outperformed the expository group on a posttest given after three days, but there was no significant difference between the expository and control (descriptive passage) groups. A posttest given after 10 days indicated that both organizer groups retained significantly more of the material to be learned than the control group.

Ausubel & Fitzgerald (1962) also conducted a second study to compare the effects of an expository advance organizer on learning from two sequential passages on endocrinology. No significant main effect was shown for either passage. However, a significant main effect was demonstrated for subjects in the lower third subgroup of a test of verbal ability as predicted by advance organizer theory. Finally, Ausubel & Youssef (1963) compared the effects of a comparative advance organizer on learning material from a passage on Zen Buddhism to a control group. They reported a significant main effect for the organizer treatment when both verbal ability and knowledge of Christianity (to which Buddhism was compared in the organizer) were controlled.

These studies appear to have demonstrated that advance organizers do facilitate learning. A recent detailed analysis of these four studies (McEneany, 1990), however, has revealed a number of problems and calls into question these results. McEneany claims no consistent evidence across the four studies in support of advance organizers nor for predicted interactions with verbal ability. He suggests that "a sound operational definition of an advance organizer eludes even Ausubel himself" (p. 95), a claim previously advanced by other writers (e.g. Hartley & Davies, 1976, Lawton & Wanska, 1977, Macdonald-Ross, 1978, Clark & Bean, 1982). McEneany (1990) was not the first to dispute the effectiveness of advance organizers. Hartley & Davies (1976) reviewed the technique as a part of a broader overview of pre-instructional strategies and, in spite of conflicting evidence, concluded that advance organizers did facilitate both learning and retention. They also claimed that a major problem lies in the design and writing of advance organizers because there were no procedures nor operationally defined steps for generating them. Ausubel, however, has disputed this on several occasions (e.g. Ausubel, 1978, Ausubel, Novak & Hanesian, 1978), claiming that sufficient guidelines can be found in his articles and books.

Barnes & Clawson (1975) were less generous. They rated 32 studies using a "voting technique" based on whether the results were statistically significant or not. Non-significant results prevailed 20 to 12 leading the investigators to a negative conclusion. They also differentiated among the studies according to length of study, ability and subject type. In each case, the count favoured non-significance. The Barnes & Clawson (1975) review, however, was itself strongly criticized on methodological grounds (Ausubel, 1978, Lawton & Wanska, 1977, Mayer, 1979a).

The Advance organizer and assimilation encoding theory

Mayer (1979a) reinterpreted Ausubel's subsumption theory in terms of his own assimilation encoding theory and reported a series of nine studies supporting his contention. This theory predicts that the organizer will facilitate both the transfer of anchoring knowledge to working memory and its active integration with the received information. It also predicts that the advance organizer may have no effect if the content and instructional procedure already contains the needed prerequisite concepts, if the content and instructional procedure are sufficiently well-structured to elicit the prerequisite concepts from the learner, or if the organizer does not encourage the learner to actively integrate the new information. Further, if the learner already possesses a rich set of relevant past experiences and knowledge and has developed a strategy for using it, the advance organizer would not be effective (for example, a high ability learner).

Thus, Mayer stipulates the following characteristics for constructing advance organizers:

1. Short set of verbal or visual information.
2. Presented prior to learning a larger body of to-be-learned information.
3. Containing no specific content from the to-be-learned information.
4. Providing a means of generating the logical relationships among the elements in the to-be-learned information.
5. Influencing the learner's encoding process
   (Mayer, 1979a, p. 382).

Mayer (1979b) also reviewed advance organizer literature. Using only published studies which contained either an advance organizer group and a control group or a post organizer group, Mayer rated 27 studies according to three questions:

1. Is the material unfamiliar, technical or lacking a basic assimilative context?
2. Is the advance organizer likely to serve as an assimilative context?
3. Does the advance organizer group perform better than the control group on a test?

He listed the results as percentages and claimed statistical significance for only three studies. He concluded that, when used, there was usually a small but consistent advantage for the advance organizer group. He also claimed that advance organizers more strongly aided performance when material was poorly integrated, that they more strongly aided inexperienced learners and that they aided transfer more than specific retention of details.

Meta-analyses of Advance Organizer Research

The summary reviews discussed previously have used a variety of techniques: the traditional literature summary (Hartley & Davies, 1976), an either/or voting technique (Barnes & Clawson, 1975), and a question-based voting technique (Mayer, 1979b). Such reviews have been strongly criticized as overly subjective (e.g. Wolf, 1986). Two later reviews of the advance organizer research literature , however, use meta-analysis, a technique which permits quantitative reviews and syntheses of the research issues (Wolf, 1986). One frequently cited meta-analytic technique is Glass' (e.g. Glass, McGaw & Smith, 1981) effect size statistic (E.S.) which allows the comparison of studies which vary in design, sample selection and setting in order to form conclusions.

The first meta-analysis (Luiten, Ames & Ackerson, 1980), examined 135 studies yielding 110 E.S. (Table 1) for learning (posttest within 24 hours of the treatment) and 50 E.S. for retention (posttest 24 hours and after). They calculated a mean E.S. of 0.21 for learning, indicating that the average subject receiving the advance organizer treatment would perform better than 58% of the control group individuals. The mean E.S. for retention was 0.26. Their conclusion was that advance organizers had a small, facilitative effect upon learning as well as retention. The effect on learning, however, runs contrary to Mayer's predictions based on assimilation encoding theory as well as Ausubel's subsumption theory. Luiten et al. (1980) also found advance organizers effective for all ability levels but especially for high ability learners (a mean E.S. of 0.23) which also contradicts both Ausubel and Mayer.

The second meta-analysis (Table 1), by Stone (1984), more closely followed Mayer's model. Stone included only studies with a control group or a post organizer and those in which a posttest was administered one week or later after the treatment. She listed 112 different E.S. from 29 studies. Stone reported an overall mean effect size of 0.66 which indicates that advance organizers facilitate the long term retention of new, unfamiliar material. However, she also compared true advance organizers, those which acted as subsumers (presented at a more general or abstract level), to those which were at the same level as the material-to-be-learned. The mean E.S. for the subsuming organizers was 0.75 while the mean for organizers taken from the material was 0.71. As well, Stone (1984) found no special facilitation for low ability learners. While generally supportive, these results contradict two main assumptions of both subsumption theory and assimilation encoding theory.

Table 1
A Comparison of Effect Sizes for the Luiten et al. and Stone Meta-analyses

Variable	Luiten et al.	Stone
learning	0.21	—
retention	0.26	0.66
low ability	0.13	0.26
medium ability	0.08	0.64
high ability	0.23	0.34

A Review of More Recent Advance Organizer Research

Has the research published since these reviews provided any further evidence to demonstrate the effectiveness of advance organizers? A comparison of several more recent studies (1984 - 1992) of advance organizers reflect the same inconsistent results (Table 2[1]). One study (Corkhill et al., 1988) consisted of six experiments to investigate retrieval context set theory. This theory holds that re-reading advance organizers before the posttest will aid retrieval of the information from long-term into working memory.

Of the six, three experiments used advance organizers without some additional activity such as paraphrasing. The mean effect sizes for these experiments are 3.75 for the cue condition (re-reading the organizer before the test of learning) and 2.24 for the no cue condition. While it can be argued that the cue condition might have added a practice effect to the presumed subsumption function of the advance organizer, the no cue condition (reported in Table 2), represents the use of advance organizers as specified by Ausubel and Mayer. Furthermore, the measure of learning in all three experiments tested retention. An average effect size of 2.24, therefore, is strong evidence for the facilitating effect of this instructional technique.

Other recent studies, however, produce much less convincing evidence. Another study by Corkhill (Corkhill, Bruning & Glover, 1988) compared the effects of concrete and abstract advance organizers on students' recall of prose. The concrete organizer was hypothesized to function as a comparative advance organizer, while the abstract organizer was expected to function as an expository advance organizer. The abstract organizer treatments produced a mean effect size of -0.62 while the concrete organizer treatments had a mean effect size of 2.25. These results are strongly conflicting since they provide support for comparative but not expository advance organizers, while both should facilitate learning and retention.

A study by Lenz, Alley & Schumaker (1986) investigated the effects of a regular teacher's delivery of an advance organizer prior to each lesson on Learning Disabled (LD) students' retention and expression of information from a given lesson. Student learning was assessed by an after-class interview recording the number of statements made by the student related to the lesson in which the organizer was used. Results indicated improvement both after teacher training and again after student training on taking notes from the organizers. The first improvement can be attributed to the use of the advance organizer per se and conflicts with Mayer's theory which indicates that it should not be effective for learning. The student training result could be ascribed as much to the generative activity of note-taking as to the advance organizer.

---

[1] **Note:** Those studies concerned with the use of advance and graphic organizers in CBI (e.g. Kenny, 1992, Tripp & Roby, 1990, 1991, Carnes et al., 1987) are included in Tables 2 and 4, but will be discussed in a later section.

Kloster & Winne (1989) conducted a study with 227 eighth grade mathematics students who were randomly assigned to one of four treatment groups: (1) expository advance organizer, (2) comparative advance organizer, (3) outline and (4) unrelated passage (control). A mean E.S. of -0.18 was obtained for the expository advance organizer and -0.15 for the comparative advance organizer indicating a slightly negative effect for advance organizers. Studies by Gilles (1984) with surgical nursing content (E.S. = 0.33 for retention) and Doyle (1986) with college mathematics (E.S. = 0.74 for learning and E.S = 1.03 for retention) indicated expository advance organizers affected both learning and retention with stronger support for the latter, thus supporting assimilation encoding theory.

A study (Tajika, Taniguchi, Yamamoto & Mayer, 1988) using pictorial advance organizers with fifth grade Japanese mathematics produced similar, and stronger, results. Mayer (1979a, p. 382) indicated that an advance organizer could be a "short set of verbal *or visual* [emphasis added] information". Students were randomly assigned to one of four groups: (1) an integrated pictorial advance organizer, which presented two geometric figures divided into component parts in an organized manner, (2) a fragmented pictorial advance organizer, which presented the same shapes but in a disorganized way, (3) a group which received extra reading time and (4) a control group which merely read the passage. They studied the organizers immediately before reading a 550 word passage about an imaginary land emphasizing geometric shapes. Students took a free recall (learning) test after reading the passage and a delayed recall test one week later. Effect sizes were highest for the retention test as predicted by Ausubel and Mayer.

Finally, four studies (Carnes, Lindbeck & Griffin, 1987, Tripp & Roby, 1990, 1991, Kenny, 1992) used advance organizers with computer-based instruction and achieved mixed results. These are discussed in the section, "Instructional Organizers with CBI".

Overall, based on the reviews and recent studies discussed above, the research evidence concerning any facilitative effect of advance organizers upon learning and retention is quite confusing. Much of the evidence appears positive, and yet, it is clearly quite variable. Effect sizes for the more recent studies range from -1.02 to 2.04 for measures of learning and from -0.18 to 4.08 for tests of retention. It may be that this range represents the distribution of study means around the true effect size mean for this instructional technique. The variability would reflect differences in experimental design, subject selection and methodology. Given the frequent discussion of the difficulty in constructing an advance organizer (e.g. Hartley & Davies, 1976, McEneany, 1990), one likely source of error is treatment fidelity. Much of this variability may reflect the lack of clarity of what an advance organizer is.

Table 2

A Comparison of Effect Sizes for Recent Advance Organizer Studies

Study	Learning	Retention
Corkhill et al. (1988)		
Expt. 3 (after 1 week)	---	1.96
Expt. 4 (after 24 hours)	---	2.85
Expt. 5 (after 2 weeks)	---	1.91
Corkhill, Bruning & Glover (1988)		
Concrete Organizer - Expt.1	1.56	---
Concrete Organizer - Expt.2	2.93	---
Abstract Organizer - Expt.1	- 1.02	---
Abstract Organizer - Expt.1	- 0.21	---
Lenz, Alley & Schumaker 1986		
After teacher training	1.03	---
After student training)	2.93	---
Kloster & Winne (1989)	—	
Comparative Organizer	---	- 0.15
Expository Organizer		- 0.18
Gilles (1984)	0.015	0.33
Doyle (1986)	0.74	1.03
Tripp & Roby (1990)	1.25	---
Tripp & Roby (1991)	0.33	---
Carnes, Lindbeck & Griffin (1987)	0.49	0.14
Tajika, Taniguchi, Yamamoto & Mayer (1988)		
Fragmented Pictorial	0.078	1.49
Integrated Pictorial	2.04	4.08
Kenny (1992)		
Adv. Org. > Partic. Graph Org.	0.45	0.95
Adv. Org. > Final Form Graph Org.	- 1.17	- 0.45
Mean	0.76	1.16

If advance organizers do affect learning, how do they achieve this effect? The inconsistent support for subsumption theory (Ausubel, 1963) and for assimilation encoding theory (Mayer, 1979a) calls their ability to predict into question. Corkhill, Bruning and Glover (1988) provide two alternate explanations. They suggest that, rather than to necessarily increase discriminability between prior learning and new material, concrete (comparative) advance organizers furnish ideational anchorage in terms already familiar to the learners, that is, to provide meaning by association with existing schema. Further, they may assist the learner to visualize the content of the organizer more readily. These authors also stress the importance of ensuring encoding of the organizer using techniques such as paraphrasing, generative techniques to be discussed below.

In summary, the jury still appears to be out on the advance organizer and the theory on which it is based. What, then, of the other variations on the advance organizer concept? The next section extends this discussion to include two of its progeny: the structured overview form of advance organizer and the pictorial graphic organizer.

Research on the Use of Graphic Organizers

The Structured Overview Form of Graphic Organizer

As discussed above, the graphic organizer was first presented as a structured overview (Barron, 1969) and meant as a variation on the advance organizer. Since it is not (e.g. Alverman, 1981), the question arises whether there is evidence that this form of organizer affects learning or retention. A meta-analysis by Moore & Readance (1984) reported an average effect size of 0.22. They also noted an average effect size of 0.57 for graphic post organizers constructed by the instructor with the class or by the student alone. They concluded that the structured overview form of graphic organizer does have an effect, especially for university students, that vocabulary learning is most positively affected and that post-organizers benefit learners more than advance organizers.

More recent studies appear to support these conclusions (Table 4). Alvermann (1981) found that partially complete advance graphic organizers had an effect on ninth grade students' comprehension and retention of text. The results indicated the strongest effect for the less well organized text as predicted by assimilation encoding theory. Two studies (Boothby & Alvermann, 1984, Alvermann & Boothby, 1986) found the graphic organizer to be effective as a strategy for facilitating fourth graders comprehension and retention of social studies text. While the second (Alvermann & Boothby, 1986) study did not test for retention, it did indicate that graphic organizers had an effect on a transfer of learning task - again predicted by Mayer's theory.

Bean et al. (1983) reported a study in which tenth grade world history students were divided into three groups: those taught to construct summaries and post graphic organizers, those taught to construct post graphic organizers only, and those taught to build outlines only. Results indicated a small effect for combined organizer and summary training group (0.16) but a negative effect for the organizer only group (-0.11). Since a true control group was not used in this study, effect sizes were calculated using the outlining group as a control.

Table 3

A Comparison of Effect Sizes for Recent Structured Overview Graphic Organizer Studies

Study	Learning	Retention
Alvermann (1981)		
Descriptive Passage	1.26	1.76
Comparative Passage	0.06	0.41
Boothby & Alvermann (1984)	0.98	0.99
Alvermann & Boothby (1986)		
Passage 1	- 0.34	---
Passage 2	0.45	---
End of chapter test	0.41	---
Bean et al. (1986)		
Organizer and Summary Training	0.16	---
Organizer Only	- 0.11	---
Carr and Mazur-Stewart (1988)	0.89	1.23
Mean	0.42	1.10

And last, Carr & Mazur-Stewart (1988) found that a vocabulary overview guide (a multi-page booklet) which included a graphic organizer was significantly superior to a traditional form of instruction in improving the vocabulary comprehension and retention of college students. While the results are neither extensive nor consistent, taken overall, these studies do indicate that the structured overview form of graphic organizer - especially the post organizer type - does affect learning and retention.

The Pictorial Graphic Organizer

A review of the pictorial graphic organizer research is reported in Table 4. Two experiments by Jonassen and Hawk (1984) tested the use of teacher-constructed participatory pictorial graphic organizers in regular classrooms (grade eight history, grade twelve English literature). The results indicated a stronger effect for learning than for retention. Two studies (Hawk, McLeod & Jeane, 1981, Hawk & Jeanne, 1983, cited in Hawk, McLeod, & Jonassen, 1985) reported statistically significant results in favour of participatory pictorial graphic organizers. However, insufficient data was available to calculate effect sizes. A more recent study by Hawk (1986) also found this technique to be effective in facilitating retention for above average students studying life science in the sixth and seventh grades.

Darch, Carnine & Kameenui (1986) compared several techniques for informing sixth grade reading students of content information, including the cooperative (group) and individual completion of participatory pictorial graphic organizers, to a more traditional directed reading approach. The graphic organizers, especially for the cooperative learning approach, were found to be more effective in facilitating retention than the traditional approach. Learning was not tested.

Alvermann (1988) investigated the effects of a final form graphic organizer (the filled in version) designed to induce tenth grade social studies students to look back in their texts for missed information. The organizer facilitated learning for self-perceived low ability students (those whose ability as measured by a standardized achievement test matched their own perception of their ability) compared to a control group of self-perceived low ability students who merely read the passage. The organizer appeared to interfere with the learning of self-perceived high ability students compared to the equivalent control group. For this study, the organizer was designed as a road map to guide students back to sections in the text in order to answer posttest questions.

Table 4

A Comparison of Effect Sizes for Pictorial Graphic Organizer Studies

Study	Learning	Retention
Jonassen & Hawk (1984)		
Experiment 1	1.17	0.67
Experiment 2	1.82	0.77
Hawk (1986)	—	0.64
Darch, Carnine & Kameenui (1986)		
Cooperative Graphic Organizer		
Individual Graphic Organizer	—	1.59
	—	0.72
Alvermann (1988)		
Self-perceived High Ability	- 0.64	—
Self-perceived Low Ability	3.94	—
Kenny, Grabowski, Middlemiss, & Van Neste-Kenny (1991)	0.59	- 0.07
Kenny (1992)		
Participatory Graph. Org. > Adv. Org.	- 0.45	- 0.95
Final Form Graph. Org. > Adv. Org.	1.17	0.45
Mean	1.09	0.48

Finally, studies by Kenny, Grabowski, Middlemiss & Van Neste-Kenny (1991) and Kenny (1992) used pictorial graphic organizers with CBIV and found evidence to support the technique. Again, these are discussed in the section on organizers in CBI.

In summary, the evidence reported above, while once again inconsistent, is generally positive. Pictorial graphic organizers of both forms appear to facilitate the learning and retention of information, at least for younger learners. Learning, though, seems to have been more consistently affected than longer-term retention of information. Taken overall, there is positive evidence for the effectiveness of all three of these techniques. The question posed by this review, however, is whether or not these results generalize to instruction delivered by CBI. Can one expect any of these techniques to help alleviate such potential problems as disorientation and cognitive overload? Research specific to the use of instructional organizers in CBI is discussed next.

While some of the advance organizer studies reviewed did use visual and oral versions, the vast majority presented a text form. Mayer's characteristics, however, indicated the acceptability of visual organizers. Therefore, it is not too large a leap of faith to presume that they might be effectively incorporated into CBI, a class of technology which can effectively combine both text and visuals. Hannafin and his associates have conducted most of the research on this topic, publishing a series of papers on orienting activities in CBI generally and CBIV in particular (e.g. Hannafin, 1987, Hannafin & Hughes, 1986, Hannafin, Phillips, Rieber, & Garhart, 1987). This research is based on the ROPES+ meta-model for designing instructional prescriptions discussed above. In a study on the effect of orienting activities in CBI with university students, Hannafin and his associates (Hannafin, Phillips, Rieber & Garhart, 1987) found that both behavioral and cognitive orienting activities improved factual learning. Their description of the cognitive orienting activity was: "designed to provide an integrative method for establishing meaningful relationships, while also serving as a subsumer of lesson detail" (Hannafin, Phillips, Rieber & Garhart, 1987, p.80). This sounds like an advance organizer. However, the one example they give, "In the next section, you will be presented information about: The importance of studying cultures." (Hannafin, Phillips, Rieber & Garhart, 1987, p.77), seems insufficient according to Mayer's characteristics.

Similarly, Hannafin, Phillips & Tripp (1986) used a one sentence cognitive orienting activity in a CBIV lesson on artists and art periods with 80 volunteer college students. They noted a significant interaction between the orienting activity and processing time but no main effect. Another study (Hannafin, 1987) compared the effects of orienting activities, cuing and practice on the learning of material on space voyages by ninth grade students. A significant interaction was found between the cognitive orienting activity and practice but the orienting activity alone was not demonstrated to be a significant instructional component. Again, the example of the cognitive orienting activity provided, "The Next Section Presents the Following Concepts: ===> Unique lighting found throughout the solar system (and) ===> Matter found throughout the solar system", also seems meagre. Rieber & Hannafin (1988) also studied the effects of textual and animated cognitive orienting activities on learning from CBI. Their subjects were 111 students from a rural elementary school presented with a lesson explaining Newton's laws of motion. Three types of orienting activities (of one minute duration each) were used: a text only, one sentence summary of the particular basic concept, an animated graphic sequence, or a combined text and graphic sequence. There was also a control (no activity) group. The orienting activities were presented throughout the lesson before each basic concept. They found no statistically significant effects for any of the orienting activities.

The orienting activities in these studies meet three of Mayer's characteristics for advance organizer construction: (a) a short set of verbal or visual information, (b) presented prior to the material-to-be-learned and (c) containing no specific content from that material. However, one could reasonably argue as well that, for none of these studies, were the cognitive orienting activities of sufficient scope to meet the other two conditions; that is, (d) generate logical relationships among elements in the to-be-learned material, or (e) to sufficiently influence the learner's encoding process. The organizing activities used in these studies were not true advance organizers. Several studies, however, did use true advance organizers in computer-based instruction. One of these studies was carried out by Carnes, Lindbeck & Griffin (1987) using a computer-based tutorial on kinematics with 100 suburban high school physics students. The advance organizers were "written according to the guidelines of Ausubel et al. (1978)" (p.785) and were presented on screen. There was no statistically significant difference between the advance organizer treatment group and a non organizer group (which read a related passage designed not to act as a subsumer). However, effect sizes of 0.49 for a test of learning and 0.14 for the retention test indicate a mild positive effect by the advance organizer.

Krahn & Blanchaer (1986) tested the use of a true advance organizer to improve knowledge application by medical students in a computer-based simulation. Post-test scores showed a statistically significant difference between the experimental and control group, both for the total scores and particular questions designed to test far transfer, as predicted by assimilation encoding theory. The test, however, was given immediately after completion of the simulation and consisted of only six questions. No validity or reliability data were provided. Insufficient data was reported to allow the calculation of effect sizes and, hence, this study was not included in the previous table (Table 2).

Tripp & Roby (1990, 1991) reported the use of an advance organizer in two studies with a Japanese-English hypertext-based lexicon. The measure of learning in these investigations was of immediate recall and was, in fact, an assessment of what the investigators viewed as rote learning. The authors reasoned, however, that the advance organizer would convey the structure of the database and, therefore, contribute to meaningful learning. Results of the first study indicated a probability coefficient of $p < 0.171$. Interestingly, despite the low p coefficient, the effect size for the organizer was 1.25, which appears to indicate a lack of power in the study. However, half of the group using the advance organizer also received a visual metaphor. A statistically significant negative effect was reported for the interaction between the two techniques. Tripp and Roby speculated that otherwise the advance organizer could have been expected to have a statistically significant effect upon learning.

In the second study, the advance organizer was rewritten to provide a metaphorical structure hypothesized to be congruent with the visual metaphor treatment. The authors reported a significant main effect for the advance organizer treatment but not for the visual metaphor, nor was there a significant interaction. Comparison of the advance organizer only treatment group mean to the control group mean, however, reveals a much smaller effect size (0.33) than the first study. The second study, though, used a considerably larger number of subjects and, with the increased power, may have produced a more accurate result. Regardless, these studies clearly contradict advance organizer theory since they demonstrated that the technique facilitated rote, rather than meaningful, learning.

Kenny, Grabowski, Middlemiss & Van Neste-Kenny (1991) compared the effects of participatory pictorial graphic organizers to those of the identical final form versions on the learning of third year nursing students from a CBIV program on nursing elderly patients with chronic obstructive pulmonary disease. The group receiving the participatory graphic organizer substantially outperformed the final form group on a test of learning, scoring an average of 1.77 points higher on an 18 question multiple choice test (E.S. = 0.59). The difference, however, was not statistically significant. As well, there was only a very slight difference between the two treatments on the retention test (given one week later) and in favour of the final form version (E.S. = -0.07). Unfortunately, considerable unanticipated extraneous note-taking by subjects in both groups confounded the differences in generativity between the two treatments. One interesting, though not statistically significant, result was that the final form graphic organizer group scored almost two points higher (on an 18 question, multiple choice test) on the retention test than on the test of learning. This may provide evidence that a final form graphic organizer behaves in a subsumptive manner akin to that posited for advance organizers.

In a subsequent study, Kenny (1992) then compared the use of an advance organizer to that of participatory and final form graphic organizers with a CBIV on cardiac nursing. In this study, it was the final form graphic organizer which was clearly the most effective treatment, garnering the highest mean scores on both tests of learning and retention. Curiously, the participatory graphic organizer group had the lowest mean scores while the advance organizer group fell in the middle. The difference between the final form and advance organizer group means was statistically significant at the $p \leq 0.05$ level for learning (E.S. = 1.17) but was not significant for retention (E.S. = 0.45). The difference between the advance and participatory organizer group means was statistically significant at the $p \leq 0.10$ level for retention (E.S. = - 0.95) but not significant for the test of learning (E.S. = - 0.45). The effect sizes reported here (and in Table 4) assume the advance organizer as a control. Extraneous note-taking was controlled. However, the cardiac program used a guided discovery approach design (unlike the pulmonary program) which demanded considerable interaction on the part of the learner and may have interacted with the organizer treatments (See the section "The Generative Learning Hypothesis").

Based on the results of these studies, there appears to be mild evidence to suggest that advance organizers and pictorial graphic organizers could be effective if incorporated in instruction based on CBI. Furthermore, this literature is congruous with the research on the use of these techniques in instruction in general, that is, the evidence of their effectiveness is mostly positive, if somewhat conflicting. Why are these generally positive results not reflected more often in the research? In the case of the studies focusing on CBI, many of the organizers did not appear to be properly constructed, that is, they were insufficient to produce a subsumptive effect. Again this may reflect the theme sounded by McEneany (1990) that a sound operational definition for the construction of advance organizers is lacking. The format and construction of the pictorial graphic organizer is similarly unclear and often (in the experience of the author) difficult. Perhaps too, however, there is a problem with the underlying theory. If subsumption theory and assimilation encoding theory are not effective in predicting when instructional organizers will be effective, will another theory be more accurate? In a discussion of the psychological underpinnings of hypermedia, Borsook & Higginbotham-Wheat (1992, p.62) note that as "we explore some of the ideas of what we know about how we learn and apply knowledge, it becomes obvious that *activity* as well as *interactivity* [emphasis added] are integral components of both theory and its application in the technology of hypermedia." Cognitive principles suggest that learning is an active, constructive process in which learners generate meaning for information by accessing and applying existing knowledge (Borsook & Higginbotham-Wheat (1992, p.64). They point out that Wittrock's (1974) generative learning theory incorporates such principles. This theory is considered next.

The Generative Learning Hypothesis

In Wittrock's (1974, p.88) view , "it is the learner's interpretation of and processing of the stimuli, not their [the stimuli's] nominal characteristics, which is primary"). Learners must construct their own meaning from teaching (Wittrock, 1985). This meaning is generated by activating and altering existing knowledge structures to interpret new information and encode it effectively for future retrieval and use. Further, generative learning involves not only generating meaning, but overt activities as well, such as generating associations among words, generating pictures, etc. (Doctorow, Wittrock & Marks, 1978). These learning activities require the learner to relate new information to an existing knowledge structure and depend on complex cognitive transformations and elaborations that are individual, personal and contextual in nature. Information is transformed and elaborated into a more individual form making it more memorable as well as more comprehensible (Borsook & Higginbotham-Wheat, 1992).

Advance organizers were developed from Ausubel's theories about meaningful verbal learning while Mayer analyzed the research in terms of assimilation encoding theory. Pictorial graphic organizers, on the other hand, while a derivative of advance organizers, are neither based on subsumption nor assimilation encoding theory. In fact, Hawk, McLeod & Jonassen (1985) recommended the participatory version because it was their belief that "the more generative the nature of student participation, the more likely it is that transfer and higher level learning will be affected" (p.179). They are referring here to Wittrock's (1974) generative learning hypothesis. Participatory graphic organizers elicit generative activity because they require the learner to actively search a body of material to select information to complete the organizer. True advance organizers, on the other hand, cannot necessarily be considered to be generative activities. They invoke a covert response on the part of learners which may or may not be generative, depending on whether or not they generate meaning between the organizer and their prior knowledge and between the organizer and the material-to-be-learned. The advance organizer does not engage the learner in overt, active learning. Of the instructional organizers considered thus far, therefore, only the participatory form of the pictorial graphic organizer advanced by Hawk, McLeod & Jonassen (1985) and the student-constructed form of structured overview (Moore & Readance, 1984) could be considered, by design, to elicit a generative response from the learner. Perhaps this explains why the research on instructional organizers, and particularly advance organizers, is so variable. Given the difficulty in determining exactly how to construct them, it may be that some investigators unknowingly designed their organizers or some other aspect of their studies such that the learners engaged in generative learning activities.

In fact, Moore & Readance (1984) note superior results for structured overview graphic organizers constructed after reading the learning passage. In support of Wittrock's hypothesis that familiar words facilitate the learners' generation of meaning for the passage (Marks, Doctorow & Wittrock, 1974, Wittrock, Marks & Doctorow, 1975), Corkhill, Bruning and Glover (1988) demonstrated the advantage of concrete advance organizers over more abstract ones, suggesting that the former furnish ideational anchorage in terms already familiar to the learners. Even the Alvermann (1988) study of final form graphic organizers directed the learners to engage in what can be argued to be a generative activity by asking them to use the organizer as a map in an active search back in the text for question answers. Thus, some of the most impressive results were garnered when students were actively engaged in the learning process.

Generative instructional organizers with CBI

Generative learning theory as applied to CBI, at least as pertains to instructional organizers, has yet to be widely tested. The few studies completed have not provided strong evidence to suggest that generative learning activities can be successfully applied to computer-based media. Two studies described earlier (Kenny, Grabowski, Middlemiss & Van Neste-Kenny, 1991, Kenny, 1992) obtained mixed results. Kenny, Grabowski, Middlemiss & Van Neste-Kenny (1991) compared the use of final form and participatory graphic organizers with CBIV and found a mild effect size in favour of the participatory pictorial graphic organizer. Kenny (1992), however, compared nearly identical participatory and final form graphic organizers to an advance organizer, again with CBIV, and found the final form graphic organizer to be the most effective on both measures of learning and retention. The group using the participatory organizer, hypothesized to be the technique most likely to elicit generative learning, achieved the lowest mean scores. However, analysis of interview data indicated that the guided discovery design of the CBIV program may have interfered with the normally generative nature of the participatory graphic organizer. In effect, the learners were already engaged in a generative learning activity, one which was quite demanding. In this situation, the normally generative organizer, rather than helping to make learning more meaningful, likely contributed to, rather than alleviated, cognitive overload.

In another study with tutorial courseware delivered by CBIV, Harris (1992) compared the use of learner-generated summaries to the completion of multiple choice questions. Contrary to predictions, the control group, which received the treatment considered to be least generative (multiple choice questions completed at the end of each module), achieved the highest mean score on a test of learning (given right after completion of the modules). Effect sizes were - 0.44 for the learner-generated summaries without feedback and -0.12 for those with feedback. None of the differences were statistically significant. Finally, Jonassen & Wang

(1992), conducted three studies on acquiring structural knowledge from hypertext. Structural knowledge is that of how concepts in a particular domain are interrelated (Jonassen & Cole, 1992). In one study (the second), Jonassen & Wang (1992) tested the use of a generative activity with the Hypercard version of their text, Hypertext / Hypermedia. The control treatment consisted of referential links embedded in the cards, while the generative treatment asked the learners to classify the nature of the relationship between the node they were leaving and the one they were traversing to. As with the Harris study, the control treatment group was generally more successful, scoring higher on the average, on a test of recall (E.S. = -0.64) and on 2 of 3 tests of structural knowledge (E.S. for relationship proximity = 0.36, E.S. for semantic relationships = 0.43 and E.S. for analogies = - 0.15). Again, none of the differences were statistically significant.

Clearly, these studies are far from conclusive. Three of these four studies use small sample sizes and may have been underpowered. Only the first provided any evidence for the effectiveness of generative activities in CBI. While, theoretically, the application of generative learning theory to the use of instructional organizers with CBI seems to hold promise, there has been little evidence to demonstrate that it more effectively predicts the effectiveness of instructional orienting activities than the theories considered previously. Is there any theory that will provide guidance? In fact, Borsook & Higginbotham-Wheat (1992) suggest that a number of theories, generative learning among them, may provide insight about how and why hypermedia may work. Perhaps most prominent among these cognitive theories is schema theory (Rumelhart & Orteny, 1977, Anderson, 1977).

Schema Theory and the Hypermap

Jonassen (1989) claimed that it is schema theory that describes the organization of human memory, not Ausubel's hierarchical, or subsumptive, model. A schema for an object, event or idea is comprised of a set of attributes, that is, associations that one forms around an idea. Schema are in turn arranged into semantic networks, sets of nodes with ordered relationships connecting them (Jonassen, 1988). Kiewra (1988) indicates that an outgrowth of schema theory has been applied research on the effectiveness of spatial learning strategies. Such strategies involve the reorganization of information into some form of spatial representation that clarifies the relationships among inherent ideas or concepts. Such representations allow information to be more readily processed since they reflect cognitive structure and provide multiple retrieval cues for accessing it. Since the graphic organizer is one form of spatial representation, schema theory may help explain the effectiveness of the technique. In the study by Kenny (1992), for instance, the filled-in (Final Form) version of the pictorial graphic organizer was most effective and may have acted as a form of cognitive map.

To reflect an individual's knowledge structure, then, an instructional organizer, rather than being at a higher, more abstract level as is an advance organizer, might be designed to reflect either novice or expert schemata, particularly if the hypermedia is unstructured. To do this, Jonassen (1989), advocated the use of hypermaps, or graphical browsers, an instructional orienting technique similar to the graphic organizer. A hypermap provides a graphical view of the program structure. The user may select a node on the hypermap and be taken immediately to that part of the program. Hypermaps represent a graphical interface between the user and a hypertext that is designed to reduce navigation problems (Jonassen & Wang, 1992). They can be expected to be effective because they should enhance the learner's structural knowledge (the knowledge of interrelationships between ideas) of the information in the program (Jonassen, 1989).

Research on hypermaps, however, has been even more scant than that on generative techniques in CBI. In one of the studies described above (the first), Jonassen & Wang (1992) compared the effectiveness of a hypermap to a control treatment consisting of referential links embedded in the cards. As with the other study, the control group outperformed the hypermap group on a recall test. The difference was statistically significant. Tests of structural knowledge acquisition, however, showed no significant differences between the techniques. In the third study, Jonassen & Wang (1992) provided learners with either a control treatment as described above or a graphical browser (or hypermap) to use for navigation. They informed half the learners in each group that they would be responsible for developing a semantic network (essentially their own hypermap) after completing the program. While this activity was ceased after only a few minutes in order to control for time-on-task, those given the semantic network task performed significantly better on the semantic relationships scale and the graphical browser/semantic network group was significantly better on the analogies subscale. In effect, the instructions to the semantic networks groups may have been sufficient to lead them to actively engage the material, that is, to elicit generative learning. The analogies subscale result, then, is one that could be explained by either Wittrock's (1974) theory, by schema theory, or both. These two studies appear to be the only ones to date testing this form of orienting activity, although a variation of the TCU knowledge mapping system (e.g. Dansereau et al., 1979) has been tested.

Like the graphical browser, the TCU knowledge map represents multi-dimensional knowledge in associative networks akin to semantic nets or schemata. Nodes denote the type and importance of the content and the spatial properties of the map clarify the organization of the domain (Reynolds and Dansereau, 1990). Perhaps the greatest distinguishing feature of the TCU knowledge map is the use of 8 specified link types to label linkages between nodes while Jonassen's version uses flexible labelling for links. Two recent studies (Reynolds and Dansereau, 1990, Reynolds et al., 1991) have presented this technique to learners in computerized form as a hypermap. Two variations of a statistics package were developed: a "standard" hypertext version and a version in which all the concepts were represented in hypermap versions of the knowledge map, that is, no standard text screens were provided. Since these studies used this format for the main body of the learning material rather than as an orienting activity, these studies are not reviewed here.

Conclusion

As has been seen, the research pertaining to the use of instructional organizers in CBI has not been extensive. Much of it has been carried out under the umbrella of the ROPES+ meta-model proposed by Hannafin and his associates. While advance and graphic organizers are included in the orienting activities category, it is doubtful that the cognitive orienting activities used by these theorists (e.g. Hannafin, 1987, Hannafin & Hughes, 1986, Hannafin, Phillips, Rieber, & Garhart, 1987) have represented forms of these techniques. Where such organizers have been constructed according to original guidelines, they have been somewhat more successful. Yet the evidence has not been consistent, a result which is perhaps not surprising given the modest results reported in past research. However, neither has the limited research testing instructional organizers on the basis of two other theories, generative learning theory and schema theory, been strongly indicative of their predictive value. Based on this review, it may be that no one theory is sufficient in and of itself to predict the effectiveness of instructional orienting techniques and to guide their design. Rather, it may be necessary to consider various theories acting in concert. As discussed previously, Borsook & Higginbotham-Wheat (1992) have suggested that a number of theories, generative learning and schema theory among them, may provide insight about how and why hypermedia may work. If the results of the third Jonassen and Wang (1992) study, which combined a hypermap treatment with a generative activity, are indicative, the design of instructional organizers may have to be based on features from various theories, each of which describes a different aspect of human cognition. While further research on both the application of generative learning and schema theory to CBI is needed, perhaps this will be most fruitful if it combines the two. Simple tests of theory may not be sufficient.

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Title:

The Effects of an Interactive Dissection Simulation on the Performance and Achievement of High School Biology Students

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ABSTRACT

Educators, administrators, and students are re-evaluating the value of animal dissection in the classroom and are taking a careful look at instructional alternatives. This research is an attempt to examine the performance, achievement, and attitudinal effects of a dissection alternative, an interactive videodisc-based (IVD) simulation, in two ways: as a substitute for dissection and as a preparatory tool used prior to dissection. Sixty-one high school students enrolled in three general ability high school biology classes participated in this research over a four day period. On the substitution issue, findings suggest that the IVD simulation was at least as effective as actual dissection in promoting student learning of frog anatomy and dissection procedures. On the preparation issue, it was found that students using the IVD simulation as a preparation performed a subsequent dissection more effectively than students receiving no preparation and more effectively than students viewing a videotape as preparation. Students using the IVD simulation as preparation also learned more about frog anatomy and dissection procedures than those who dissected without preparation. Students in all groups evidenced little change in attitudes towards dissection. All students reported a significant gain in dissection self-efficacy, but no between group differences were found. Findings are discussed relative to their implications for educational practice and future research.

The Effects of an Interactive Dissection Simulation on the Performance and Achievement of High School Biology Students

Frog dissection in our nation's high schools is widespread. It has been estimated that 75 to 80% of the country's four million biology students dissect frogs (Orlans, 1988a). As part of a growing controversy over the use of animals for dissection, some of these students are refusing to conduct dissections on moral grounds. Animal rights groups have developed student and educator outreach programs encouraging alternatives to dissection. Legislation has been passed in some states protecting the rights of students who do not wish to participate in dissection. Many educators contend, however, that there is merit in conducting dissections to assist students in learning about the anatomy and biological functioning of animals.

The research reported here is an attempt to examine the effects of a dissection alternative, a videodisc-based simulation, in two ways. First, because it is of interest to determine if such an alternative could be as effective a learning tool as actual dissection, the effects of the simulation were compared to those of an actual dissection. Relevant outcomes were student achievement on a test of frog anatomy and dissection procedures and dissection-related attitudes and self-efficacy. Second, because many educators believe in the value of dissection, the simulation was examined as a preparatory tool, used prior to dissection. Here the achievement, attitude, and self-efficacy scores were also employed, along with a measure of students' actual dissection performance. Comparisons were made between the following groups: (a) students receiving the interactive videodisc-based simulation as preparation, (b) students viewing a linear videotape (containing the same video images as the simulation but without the interactive practice) as preparation, and (c) students receiving no preparation.

In this paper, we briefly outline the controversy surrounding dissection. We go on to describe the design of the videodisc simulation, followed by a presentation of research methods and results. Finally, the results will be discussed with regard to their implications for educational practice and future research.

Origins of Dissection in the Biology Classroom and the Current Controversy

Animals have been dissected in biology classes since the early 1900's. According to Orlans (1988a) it is believed that dead frogs first became available from commercial suppliers between 1910 and 1920. Even though frog dissection was not included in the first formal biology textbook published in 1921, it had become an established laboratory activity in the nation's high schools by the 1920's. By the 1960's, frog dissection had become very popular as a result of the new biology curricula developed by the Biological Sciences Curriculum Study (BSCS) (Hairston, 1990). As mentioned previously, by 1988 it was estimated that 75 to 80% of this country's four million biology students were dissecting frogs (Orlans, 1988a).

In recent years animal dissection has come under increased scrutiny. As a result of several judicial and legislative decisions, students, teachers, and administrators are being compelled to re-evaluate the morality and instructional effectiveness of this use of animals. The California and Florida legislatures passed bills protecting the rights of students who do not wish to participate in dissection (Orlans, 1988a). Massachusetts considered similar legislation in 1990 (Smith, 1990).

Some science educators and scholars, such as Orlans (1988a, 1988b), advocate replacing the traditional dissection lab with the study of live organisms. Others, such as Berman (1984), Hoskins (1979), and Igelsrud (1986, 1987), express support for dissection. Their support, however, is conditional upon the use of great care and planning in the design of lessons using animal specimens.

The National Association of Biology Teachers (NABT) policy statement, "Animals in Biology Classrooms," recognizes the long history of animal dissection in biology education and the educational value of "well constructed dissection activities conducted by thoughtful instructors"

(Hairston, 1990, p. x.) Nevertheless, the NABT statement suggests that biology teachers reexamine their reasons for including animal dissection in their courses and consider using alternatives.

Currently available alternatives include books, charts, computer programs, models, filmstrips, slides, transparencies, videotapes, and videodiscs. Many of these, however, can be faulted for their lack of realism and opportunities for student involvement. Furthermore, little research has been conducted to evaluate their effectiveness. Film or video-based alternatives have the greatest potential to accurately depict the animal being studied since they show actual specimens. Results of research comparing the use of two film-based alternatives to actual dissection in medical and veterinary anatomy instruction suggest that such alternatives can be as effective as dissection in promoting cognitive outcomes (Prentice et al., 1977; Welser, 1969).

The Interactive Frog Dissection

Since the film-based dissection alternatives mentioned above were evaluated, interactive videodisc technology (IVD) has emerged as an instructional tool of great potential for instructional simulations. Iuppa (1984) defines interactive video as "any video system in which the sequence and selection of messages is determined by the user's response to the material" (p. 5). This feature, which allows learners to experience consequences to their decisions, is probably the most significant feature of IVD. IVD-based simulations take advantage of the medium's high quality audio and video, instant random access capability (any location on a videodisc can be accessed in two seconds or less), playback flexibility (e.g., variable speed and direction, different audio tracks depending on user performance), and storage capacity (up to 54,000 still images or 30 minutes full-motion video). These features are then coupled with a microcomputer's text, graphics, and videodisc control capabilities.

An IVD-based simulation of frog dissection, called The Interactive Frog Dissection was developed by Strauss and Kinzie (1991) as a research tool to study the potential of dissection alternatives. It includes demonstrations of frog dissection and depictions of frog anatomy interspersed with practice activities on dissection procedures and anatomical identification. Additional directions, explanations, and feedback are supplied in response to student input, ensuring a high degree of interactivity.

Results from pilot research suggest that students using The Interactive Frog Dissection learn as much about dissection procedures and frog anatomy as students conducting an actual dissection (Strauss & Kinzie, in press). The following study continues this investigation, comparing the achievement and attitudinal effects of the simulation to those of laboratory dissection, and extending the exploration to include the use of the simulation as a preparatory tool prior to dissection.

METHOD

Subjects:

Participating in this research were 61 students (33 male and 28 female) at a high school located near a small mid-Atlantic city. The participants were an average age of 15.30 (*SD* = 0.92) and were enrolled in three general ability biology classes taught by a single instructor. Seventy-seven percent (*n* = 47) reported participating in a previous dissection, all but one occurring in the seventh grade. The study was conducted over four consecutive days following a unit on human anatomy.

Procedures:

Students in each of the three classes were randomly assigned to one of four groups: (1) the IVD Prep group used the interactive videodisc-based simulation as a preparation for laboratory dissection (*n* =16); (2) the Video Prep group viewed a linear videotape containing the same video materials used in the IVD simulation, but without interactivity (*n* = 15); (3) the Diss Only group conducted the dissection without preparation (*n* = 15); and (4) the IVD Only group used the IVD simulation but did not dissect (*n* = 15). Within each group, students were randomly assigned to teams of two or three each. Preliminary analyses indicated that there were no significant between-group differences on the biology course grade earned prior to that point in the semester.

On the first day of the study, the teacher told the students that they would be helping to evaluate some instructional activities related to dissection. The teacher explained that because there were not enough computers for everyone to use them at once, they would be splitting up into groups, with different groups sometimes engaging in different activities. Students were also informed that everyone would have the opportunity to use the computers. (Even students whose instructional treatment did not include use of the computer-based simulation were given the opportunity to use the simulation after completion of data collection.) Students then completed the achievement pre-test and attitude and self-efficacy pre-measures. There were no significant differences between treatment groups on pretest achievement, attitude, or self-efficacy.

On day two, students in the IVD Prep group used the simulation, students in the Video Prep group viewed the videotape, and students in the Diss Only or IVD Only groups completed library research for an unrelated biology assignment. For their use of the simulation, students in the IVD Prep group broke into their randomly assigned teams (two teams per class period). Each team worked through the simulation at one of two IVD stations located in their classroom. IVD Prep students spent an average of 39.4 minutes (*SD* = 3.6) on the dissection simulation. Students in the Video Prep group went to a nearby classroom to view the videotape, which lasted 15 minutes. On completion of the videotape, the Video Prep students went to the library to work on an unrelated biology assignment.

During day three, student teams in the IVD Prep, Video Prep, or Diss Only groups completed a frog dissection laboratory at laboratory benches in their classroom. Students in the IVD Only group broke into their two teams and used the interactive videodisc-based simulation. The IVD stations were placed in corners of the classroom some distance away from the laboratory benches and the other students. There was very little to no interaction between students conducting the dissection and students using the simulation. All students were engaged in their respective activities for the duration of the class period. On the fourth and final day, students in all groups completed the achievement post-test and the attitude and self-efficacy post-measure. Students were told that their grade on the posttest would count towards their course grade, so that they should try hard to do well. On day four, one student was absent and was dropped from all analyses involving any of the post-measures. Another student was called out of class during the posttest; this student was dropped from analyses involving the posttest.

Materials:

Students in the IVD Prep and IVD Only groups used the interactive videodisc-based simulation previously described. The videotape used in Video Prep treatment was taken from the simulation videodisc. It presents and reviews dissection procedures then presents and reviews frog anatomy, but differs from the IVD materials in that it does not provide opportunities for practice.

Student teams conducting the dissection on day three received a lab handout detailing dissection procedures through diagram and description. The dissection procedures parallel those presented in the IVD and Video materials. The lab handout instructed teams to locate various organs during the dissection. In teams with three students, one student selected the job of surgeon, another acted as assistant surgeon, and a director relayed instructions. In two-member teams, the assistant surgeon also relayed instructions.

Criterion Measures:

The 30-item achievement test was composed of several parts measuring knowledge of frog anatomy and dissection procedures. Part One provided three diagrams on which students were directed to find and label ten organs. During Part Two, students went one at a time to lab stations to examine four previously dissected frogs marked with 11 numbered pins. Students named the organs marked by the pins. In Part Three, students answered nine multiple choice questions (four response options each) about dissection procedures. Inter-item consistency reliability (KR_{20}) calculated from the post-test administered during this study was .58, suggesting some degree of heterogeneity in the content domain sampled.

The Attitudes Toward Dissection measure was constructed of 20 items with a four-point Likert-type response scale. Ten of the items were adapted from those used by Strauss & Kinzie (1992). Ten additional items were developed specifically for this research. Half of the items are positively phrased and half are negatively phrased, as described by Gable (1986). Before administration of this measure, it was reviewed and critiqued by six high school science teachers and six educational technologists, and subsequently revised. Inter-item consistency (Cronbach's alpha) of this instrument was calculated from the post-administration in this study; it is estimated to be .94. The Attitudes Toward Dissection measure is contained in the Table 1.

Insert Table 1 about here

The self-efficacy measure contains 25 items which elicit respondent confidence in performing various dissection procedures and confidence in identifying portions of frog anatomy. Students indicated their level of agreement on a four-point Likert scale to items beginning with "I feel confident..." and ending with phrases such as "pinning the muscle flaps to the tray," and "locating the gall bladder." Alpha reliability of this measure was calculated from student response to the post-administration during this study (r_{ii} = .99), and indicates a high level of internal consistency.

During the dissection laboratory, six student teams worked at six lab benches, three on each side of the classroom. Four researchers observed and evaluated dissection performance. The researchers were educators well-trained in dissection procedures. Two researchers observed on each side of the classroom using a 41 item checklist (Y/N) to evaluate team performance. Checklist items parallel dissection procedures outlined in the lab handout and preparatory materials. The checklist contains items such as, "Lifts muscle tissue with forceps?" and "Identify kidneys?" Teams who correctly performed a step in the dissection or successfully identified a specific organ were awarded a "Y" rating; those that did not received a "N;" all Y ratings yielded one point towards the overall evaluation score. In the event that a team was not performing a step properly or could not identify an organ, the researcher assisted by describing the appropriate technique or indicating the organ. Each researcher evaluated one team alone, and one team in consort with another researcher. This was to ensure reliability of the evaluation. In all cases, joint observation yielded congruent evaluation ratings.

Finally, four questions soliciting student preferences for various study activities were included at the end of the affective post-measures. Students were asked, "If you were given a choice of study activities in school, which would you prefer?" Students selected one choice from each of the following pairs: 1) Studying frog dissection and anatomy *or* studying another topic within biology; 2) Watching a videotape or film on dissection *or* using a computer program on dissection; 3) Using a computer program or watching a videotape or film on dissection *or* conducting an actual dissection; and 4) Conducting a dissection after using a computer program or after watching a videotape or film on dissection *or* conducting a dissection without using any prior instructional materials.

Design:

This study employed a pre-test/post-test design. One-way Analysis of Variance and Covariance (ANOVA, ANCOVA) procedures were employed, except where noted. All Analyses were completed with SPSS PC+ v. 3.0.

RESULTS

As shown in Table 2, all subjects evidenced significant gains in achievement test performance between the pretest (*M* = 10.05 out of 30 possible, *SD* = 3.96) and post-test (*M* = 21.24, *SD* = 4.76). Repeated Measures analysis indicates this overall gain to be significant, $F(1, 58) = 238.00, p<.0001$. Attitudes toward dissection remained relatively stable from day one (*M* = 50.89 out of 80 possible, *SD* = 11.42) to day four (*M* = 52.50, *SD* = 12.21). Self-efficacy with dissection procedures, on the other hand, increased from the administration of the pre-measure (*M* = 64.95 out of 100 possible, *SD* = 20.21) to completion of the post-measure (*M* = 72.73, *SD* = 20.44), *F*(1, 58) = 17.01, p<.0001.

Insert Table 2 about here

In the analyses that follow, premeasure scores are used as covariates in the examination of postmeasure scores. To begin, overall analyses were conducted on each measure. The outcomes indicated treatment effects for Achievement, (depicted in Table 3) and Dissection Performance (shown in Table 4). No treatment-related differences were suggested for Attitudes, Self-Efficacy, or Dissection Time. Teams required an average of 36.69 minutes overall (*SD* = 6.86) for the dissection. Planned comparisons were then conducted on Achievement and Dissection Performance.

Insert Tables 3 & 4 about here

Simulation versus Dissection

The first comparison contrasted subjects receiving the interactive videodisc-based simulation only (IVD only) with those conducting the dissection only (Diss Only). No achievement differences were found between the IVD only group (M_{gain}=10.00) and the Diss Only group (M_{gain}=7.87).

Interactive Simulation as Preparation

The second and third planned comparisons were directed to determine the relative efficacy of using the IVD-based dissection simulation as a preparation for students who will go on to conduct dissections. To examine the effects of the interactive simulation as preparation versus no preparation at all, IVD Prep subjects were compared to Diss Only subjects on both dissection performance and achievement. Next, to determine the relative effects of interactive practice during the dissection preparation, subjects in the IVD Prep group were compared to those in the Video Prep group, again examining dissection performance and achievement outcomes.

Dissection Performance. Subjects who used the dissection simulation as preparation for the actual dissection (IVD Prep, *M* = 38.94 out of 41 possible, *SD* = 2.08) were found to be more effective in conducting the dissection than those who had received no preparation (Diss Only, *M* = 32.21, *SD* = 4.53), *F*(1,28) = 28.52, *p*<.0001. The dissection simulation with its interactive practice activities also proved to be more effective than than linear videotape (Video Prep, *M* = 33.13, *SD* = 5.94) in preparing students to conduct dissections, *F*(1,29) = 13.54, *p*<.001. Table 5 contains the results of these Dissection Performance analyses.

Insert Table 5 about here

Achievement. Students given the IVD simulation as preparation (IVD Prep, M_{gain}=14.69) learned more than students not given any preparation prior to conducting a dissection (Diss Only, M_{gain}=7.87), *F*(1,28) = 15.24, *p*<.001. No difference in achievement was found between IVD Prep subjects and Video Prep subjects (M_{gain}=12.23). See Table 6 for the statistical summaries.

Insert Table 6 about here

The Value of Dissection after IVD Preparation

In the final planned comparison, students using the dissection simulation followed by actual dissection (IVD Prep) were compared to those using the simulation without dissection (IVD only). The intent was to determine the additive effects that actual dissection might have following use of the simulation. Statistical outcomes (see Table 6) suggest that the combination of the interactive dissection simulation and actual dissection (M_{gain}=14.69) was more effective in promoting overall achievement than the simulation alone (M_{gain}=10.00), $F(1,28) = 7.56$, $p<.01$.

Preferences for Study Activities

Multivariate analysis of variance (MANOVA) outcomes indicated no significant between-group differences at the multivariate level in subject preferences for study activities. Subjects were then pooled and their responses analyzed via the Chi Square test to determine if their expressed preferences were significantly different from those expected by chance (50%). Subjects reported a strong preference for dissection when preceded by some form of preparation (computer program, video, or film) (87%) over dissection without any such preparation (13%), χ^2 (1, N = 60) = 30.82, $p<.001$. Preferences were also expressed for use of a computer program on dissection (68%) over a related video of film (32%), χ^2 (1, N = 60) = 7.35, $p<.01$. No significant differences were noted between student preferences for use of a dissection substitute (computer program, video or film) and actual dissection, or between the study of dissection and anatomy and another topic within biology.

DISCUSSION

Achievement and Performance

Several interesting achievement outcomes were obtained in this research. First, an interactive dissection simulation was found to be at least as effective as actual dissection in promoting learning about frog anatomy and dissection procedures. This outcome supports the preliminary results reported by Strauss & Kinzie (1992) with the same dissection simulation, as well as outcomes reported by Prentice et al. (1977) and Welser (1969). At the least, these results suggest that effective alternatives can be offered to students or educators who desire other approaches to learning about vertebrate anatomy.

A second finding of note was the effectiveness of the interactive dissection simulation as preparation for actual dissection. Students using the simulation as preparation performed more effectively during the dissection than those who had received no preparation, and more effectively than students viewing a linear videotape as preparation. The differential effectiveness of student teams during actual dissection is not to be minimized--in a typical classroom containing 20 to 30 students, a single instructor is hard-pressed to lend assistance to all student teams conducting a dissection. In this study the four researchers present during the dissection laboratory were busy with only six dissection teams. Instructional preparation which can ensure student effectiveness in upcoming laboratory situations has indisputable value.

The performance advantage for the IVD Prep treatment tended to translate into an achievement benefit as well: students using the interactive simulation as preparation for the dissection learned more overall than students receiving no preparation. And as might be expected, following an instructional activity like the interactive videodisc-based dissection simulation with an actual dissection led to greater overall learning than use of the simulation alone.

It could be argued that the apparent advantage of the dissection simulation over the linear videotape was due not to the provision of interactive practice but rather to the time differential between the two treatments: IVD Prep subjects spent an average time of 39.4 minutes with the simulation; Video Prep subjects viewed the videotape for 15 minutes. However, since identical video materials were displayed in both treatments, the time differential was due solely to the interactive practice activities contained in the dissection simulation.

Attitudes and Self-Efficacy

That no significant changes were found in attitudes towards dissection is not surprising; theorists have long contended that affective values are relatively stable and are modified only over time

(Dick & Carey, 1990; Kerlinger, 1973). Self-efficacy with dissection procedures increased for all groups as a result of their activities, but no between-group differences were significant.

Preferences for Study Activities

Results of the Chi square analyses suggest the value that students perceive in appropriate preparation for dissection: 87% of the participants in this study indicated a preference for dissection when preceded by a computer program, videotape, or film on dissection while only 13% preferred a dissection without preparation. The results of these analyses also point to the attraction that computers may hold for individuals in this population--about two-thirds of the students expressed a preference for use of a computer-based program on dissection over a related video or film.

Recommendations for Educational Practice

As mentioned previously, findings reported here suggest the efficacy of providing a dissection simulation as an alternative to laboratory dissection. For those educators who do not have access to interactive videodisc hardware and software, other viable dissection alternatives exist (though they were not tested in this research): use of less sophisticated computer programs, activities involving anatomical models, and the study of live frogs in the classroom (Hairston, 1990).

However, use of such a simulation is not the equivalent of performing a laboratory dissection: students viewing frog specimens on a computer screen will not have the same sensory experience as students examining actual frog tissues and organs. They may not feel the same sense of personal discovery. For these reasons, some educators may prefer to include dissection laboratories in their biology classes. Results obtained here underline the importance of preparing students for the dissection experience. If possible this instructional preparation should include dissection-related practice activities. In this study, students who received interactive practice performed subsequent dissections much more effectively and required much less assistance than those who viewed a linear videotape as preparation or those receiving no preparation at all. The IVD preparation group also learned more than did the group conducting a dissection with no preparation. Students across groups expressed a preference for dissection when prepared by computer program, videotape, or film over dissection alone, and a preference for use of computer programs as preparation over videotape or films for the same purpose.

Finally, following up an activity like the dissection simulation with actual dissection may lead to increased learning over use of the simulation alone. It should be noted, however, that alternative learning activities besides dissection could be considered as valuable follow-up activities. It is conceivable that the achievement benefit found for the simulation plus dissection could also be found for the simulation followed by any number of other activities focusing on frog anatomy.

Recommendations for Future Research

Among the research possibilities in this area are explorations involving the various dissection alternatives that exist. What is their potential relative to laboratory dissection to enhance student learning? Could a dissection simulation be followed up by other activities besides dissection for achievement gains similar to those found here? Through research projects such as these, we can better define the attributes of instructional activities having the most educational potential for biology classrooms.

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Table 1

ATTITUDES TOWARD DISSECTION Measure

SURVEY: HOW DO YOU FEEL ABOUT DISSECTION?

This survey has 20 statements about the use of dissection for educational purposes. After reading each statement, please indicate the extent to which you agree or disagree, by circling the number to the right of each statement. Please respond to all statements. There are no correct or incorrect responses.

		I Strongly Disagree	I Disagree	I Agree	I Strongly Agree
1.	I don't see how frog dissection will help me to learn about frog anatomy.	1	2	3	4
2.	Animals can be treated with respect in a dissection.	1	2	3	4
3.	Dissection is an unpleasant activity.	1	2	3	4
4.	Biology students should dissect an animal to help them learn about anatomy.	1	2	3	4
5.	I am disturbed by the idea of dissecting an animal.	1	2	3	4
6.	Dissection makes biology more interesting.	1	2	3	4
7.	Dissection is not a useful way to learn about the structure and function of animals.	1	2	3	4
8.	It is morally acceptable for man to harm or destroy animals for education and research.	1	2	3	4
9.	I believe dissection is an effective way to study the anatomy of an animal.	1	2	3	4
10.	I feel comfortable with the idea of conducting a dissection.	1	2	3	4
11.	To help me learn about anatomy, there are more practical activities than dissection.	1	2	3	4
12.	Animals should not be harmed for the purposes of education and research.	1	2	3	4
13.	Learning about frog anatomy through dissection will help me to learn about the anatomy of other organisms.	1	2	3	4
14.	I do not think that learning about frog dissection will be useful.	1	2	3	4
15.	Dissection increases my respect for animals.	1	2	3	4
16.	My biology class would be more enjoyable without dissection.	1	2	3	4
17.	I feel okay about dissecting a frog in order to learn about frog anatomy.	1	2	3	4
18.	It is not very interesting to conduct a dissection and learn about frog anatomy.	1	2	3	4
19.	The study of anatomy does not justify the dissection of a biological organism.	1	2	3	4
20.	I am interested in finding out first-hand about frog anatomy through dissection.	1	2	3	4

Table 2

Mean Achievement, Attitude, Self-Efficacy, and Performance Scores

		Achievement		Attitudes		Self-Efficacy		Dissection
Group	n	Pre	Post	Pre	Post	Pre	Post	Perf
Entire Group	61							
M		10.05[a]	21.24	50.89[b]	52.50	64.95[c]	72.73	34.91[d,e]
SD		3.96	4.76	11.42	12.21	20.21	20.44	5.30
IVD Prep	16							
M		8.81	23.50	50.56	53.69	72.56	79.00	38.94
SD		2.29	2.90	10.42	10.40	17.87	15.54	2.08
Video Prep	15							
M		10.33	22.46	49.60	53.14	61.87	74.36	33.13
SD		5.22	4.88	12.60	11.22	18.64	18.27	5.94
Diss Only	15							
M		10.73	18.60	52.93	53.67	60.87	69.27	32.21
SD		4.13	5.53	9.84	14.08	21.46	24.66	4.53
IVD Only	15							
M		10.40	20.40	50.47	49.47	63.93	68.00	-
SD		3.83	4.32	13.42	13.55	22.63	22.37	-

[a] Total Score, out of 30 possible.

[b] Total Score, out of 80 possible. Higher Scores indicate more positive attitudes towards dissection.

[c] Total Score, out of 100 possible. Higher Scores indicate greater levels of perceived self-efficacy with dissection procedures

[d] Total Score, out of 41 possible.

[e] Mean Dissection Performance Score for the Entire Group excludes IVD Only subjects, who did not conduct the dissection.

Table 3

ANCOVA Outcomes for all Treatment Groups on Achievement

Source	SS	df	MS	F
Pretest[a]	46.78	1	46.78	2.50
Treatment	258.88	3	86.29	4.61**
Error	1011.02	54	18.72	

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[a] Pre-measures were employed as covariates in all ANCOVA procedures.

** $p < .01$

Table 4

ANOVA Outcomes for all Groups on Dissection Performance[a]

Source	SS	df	MS	F
Treatment	408.62	2	204.31	10.40***
Error	825.03	42	19.64	

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[a] Includes only those groups that conducted a dissection.

*** $p < .001$

Table 5

ANOVA Outcomes for Planned Comparisons on Dissection Performance

IVD Prep vs. Diss Only

Source	SS	df	MS	F
Treatment	337.50	1	337.50	28.52****
Error	331.30	28	11.83	

IVD Prep vs. Video Prep

Source	SS	df	MS	F
Treatment	260.81	1	260.81	13.54***
Error	558.67	29	19.26	

*** $p < .001$
**** $p < .0001$

Table 6

ANCOVA Outcomes for Planned Comparisons on Achievement

IVD Prep vs. Diss Only

Source	SS	df	MS	F
Pretest[a]	28.35	1	28.35	1.72
Treatment	250.64	1	250.64	15.24***
Error	460.49	28	16.45	

IVD Prep vs. Video Prep

Source	SS	df	MS	F
Pretest	1.98	1	1.98	0.13
Treatment	9.53	1	9.53	0.61
Error	407.46	26	15.67	

IVD Prep vs. IVD Only

Source	SS	df	MS	F
Pretest	11.08	1	11.08	0.87
Treatment	95.83	1	95.83	7.56**
Error	355.09	28	12.68	

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[a] The Achievement Pretest served as covariate in these ANCOVA procedures.

** $p < .01$

*** $p < .001$

Title:

Effects of Cooperative Learning and Incentive on Motivation and Performance

Authors:

James D. Klein
John A. Erchul
Doris R. Pridemore

Effects of Cooperative Learning and Incentive on Motivation and Performance

A number of studies have been conducted to compare cooperative and individual learning strategies. According to Johnson & Johnson (1989), a cooperative learning strategy allows students to work together to increase performance and achieve shared goals; an individual learning strategy requires students to work by themselves to accomplish their own goals. Several reviews of research suggest that cooperative learning affects student performance, productivity, transfer of learning, time on task, and attitude (Johnson & Johnson, 1989; Rysavy & Sales, 1991; Sharan, 1980; Slavin, 1990).

The results of cooperative learning research has inspired instructional technologists to examine how cooperative groups can be implemented with media originally designed for individual learning. Results of studies conducted to investigate cooperative learning and computer-assisted instruction are mixed. Some researchers report that cooperative learning positively affected performance in CAI lessons (Dalton, Hannafin, & Hooper, 1989; Johnson, Johnson, & Stanne, 1985), while others have not found a significant effect for performance when learners used cooperative CAI (Carrier & Sales, 1987). Research on cooperative learning and instructional television suggests that students working in groups are more motivated than those who work alone, but performance in these settings is influenced by one's affiliation motives (Klein & Pridemore, 1992).

The mixed results in studies that have examined cooperative learning with media may be due to the rewards provided to students. Some scholars indicate that providing rewards to students who work in cooperative groups can negatively impact their achievement, interest, and continuing motivation (Kohn, 1991). However, many researchers suggest that providing rewards to students is an important component in cooperative learning (Johnson & Johnson, 1989; Sharan, 1980; Slavin; 1990).

Researchers have distinguished between cooperative and individualistic reward structures (Deutsch, 1949; Johnson & Johnson, 1974; Michaels, 1977; Slavin, 1977). A cooperative reward structure provides all members of a group the same reward based on the performance of the whole group. An individualistic reward structure provides each individual with a reward based on their own performance.

In cooperative learning settings, the effect of these types of rewards on performance is unclear. Slavin (1991), suggests ". . . almost every study of cooperative learning in which the cooperative classes achieved more than the traditional control groups used some sort of group reward" (p. 89). However, other researchers have not found cooperative rewards to be superior to individualistic rewards when performance is measured (Hamblin, Hathaway, & Wodarski, 1971; Michaels, 1977; Niehoff & Mesch, 1991). These results may be due to the type of individualistic reward offered to students who work in cooperative groups.

The purpose of the current study was to examine the effect of cooperative learning and type of reward on performance and continuing motivation. The study is a continuation of a program of research designed to investigate how cooperative groups can be implemented with media originally designed for individual learning.

Method

Subjects were 126 undergraduate education majors (30 males, 96 females) in the first semester of a teacher training program at a large southwestern university. All subjects were enrolled in a required course in educational psychology; participation in the study fulfilled a requirement for this course.

Materials used in this study were an instructional television lesson, a posttest, and a continuing motivation survey. The instructional television lesson was from the series Instructional Theory: A nine unit mini-course (Gerlach, 1973). The lesson included a videotape and a workbook that provided instruction on the topic of objectives-based assessment. The videotape was approximately 30 minutes in length. It was divided into seven segments which presented information and examples on the content of the lesson. After each segment, the videotape instructed subjects to turn to their workbook for practice and feedback on the content presented in that segment. Performance was measured using a 15-item, constructed response posttest. The items were developed to evaluate student mastery of the instructional objectives for the lesson on objectives-based assessment. The maximum score on the posttest was twenty points. Individual answers were checked against a scoring key and points were assigned for each answer. Partial credit was given for questions that required a multiple response. One person scored all of the items on this test. The Kuder-Richardson internal-consistency reliability of the posttest ranges from .69 to .81 (Klein & Pridemore, 1992). Continuing motivation was assessed using a paper and pencil survey. This survey consisted of seven items that measured the degree to which a subject would want to return to tasks like those used in the study. The Cronbach alpha internal-consistency reliability estimate of this survey was .60.

Subjects were randomly assigned to one of six treatment conditions. All possible combinations of instructional method (individual versus cooperative) and type of reward (task, performance, none) were equally represented after assignment to groups. Additional random assignment was conducted for the cooperative learning treatments; subjects in these conditions were randomly assigned to groups of three (triads).

At the beginning of the lesson, subjects in all treatments were informed that they would be viewing an instructional television program on objectives-based assessment and that they would be using a workbook to receive practice and feedback on the content of the lesson. Subjects were told to write the answer to each practice exercise in the workbook and read the feedback that followed each exercise. In addition, subjects in all groups were directed to read the first two pages of the workbook to receive the lesson objectives and were told that they would each be completing a test on the content of the lesson. Other procedures and directions were different depending on treatment condition. Subjects received specific directions for implementing either an individual or a cooperative learning strategy. Subjects working alone were each given a workbook, instructed to work independently during the lesson, and told to do their best work. Subjects in the cooperative learning conditions were randomly assigned to a triad. Each triad was given a workbook and told to (a) work together during the lesson, (b) discuss all practice exercises and any disagreements over the answers, and (c) discuss the given feedback.

Subjects also received specific directions concerning the reward for learning depending on their treatment group. Subjects in the task reward groups were told, "Your participation in this lesson is worth ten points toward your course grade." Subjects in the performance reward groups were told, "Your participation in this lesson can be worth as much as ten points, but the number of points you earn depends on how much you learn from the lesson." Finally, subjects in the no reward groups were told, "Your participation in this lesson will help you to be successful both on the final exam and on the course project."

After the above instructions were provided, the videotape was started for each treatment condition. When Segment 1 was completed, the tape was stopped and subjects did Exercise 1. When Exercise 1 was completed, the videotape was started again. This cycle was continued until all seven sections of the lesson were finished. Upon completion of these activities, all workbooks were collected and each subject individually completed the continuing motivation survey. One week later, all subjects were given the posttest and were required to work individually to complete it. One week after the posttest session, subjects were informed that each of them would earn ten points toward their course grade regardless of how well they did on the posttest.

Results

Analysis of variance (ANOVA) revealed that type of instructional method had a significant effect on performance, $F(1, 119) = 4.07$, $p < .05$, $MSe = 13.76$, $ES = .34$. Subjects who worked alone performed better on the posttest ($M = 11.9$, $SD = 3.7$) than those who worked cooperatively ($M = 10.6$, $SD = 3.6$). Type of reward did not have a significant effect on performance. Furthermore, a significant interaction between instructional method and type of reward was not found.

Multiple analysis of variance (MANOVA) suggested that type of instructional method had a significant effect on continuing motivation, $F(7, 113) = 4.10$, $p < .001$. Type of reward did not affect continuing motivation and a significant interaction between instructional method and type of reward was not found. Univariate analyses revealed that subjects who worked alone expressed more continuing motivation than those who worked cooperatively for instructional television programs that require individual work, $F(1,119) = 16.23$, $p < .001$, $MSe = 1.34$, $ES = .69$, and for other activities that require individual work, $F(1,119) = 7.50$, $p < .01$, $MSe = 1.44$, $ES = .48$. In addition, subjects who worked cooperatively expressed more continuing motivation than those who worked alone for activities that require working with other students, $F(1,119) = 5.82$, $p < .05$, $MSe = .94$, $ES = .42$.

Discussion

The purpose of this study was to explore the effect of cooperative learning and type of reward on performance and continuing motivation. Subjects used either a cooperative or individual learning strategy while receiving information, examples, practice, and feedback from an instructional television lesson.

Results indicated that subjects who worked alone performed better and expressed more continuing motivation than those who worked cooperatively. These findings lend support to other studies which suggest that a cooperative strategy may not affect educational outcomes in some settings. While cooperative learning has influenced student performance and attitudes in classroom settings (Johnson & Johnson, 1989; Sharan, 1980; Slavin, 1990), cooperative learning has not always influenced performance when it is implemented with media originally designed for individual learning (Carrier & Sales, 1987; Klein & Pridemore, 1992).

The results of the current study may have occurred because of how students approach learning from instructional television lessons. In our society, television viewing is an individual experience with little opportunity for interaction among viewers. Furthermore, television is typically implemented for individual use in instruction. Most students have very little practice working with other people when using instructional television lessons.

Even though subjects in the triads were given specific directions for implementing a cooperative strategy during the lesson, informal observations suggest that many groups did not follow these directions. After each segment of the tape was stopped, subjects in several of the triads quietly read the question in the workbook to themselves. One of the group members would usually ask the others for the answer and would write it in the workbook. Very little on-task discussion occurred in these groups. Groups that finished the practice before other triads in the room would usually talk about topics that were unrelated to the lesson. These behaviors are somewhat different than those of the subjects who worked alone. After reading the each question and answering it, many individuals who finished the practice before others in the room usually reviewed the item or looked ahead to the next item in their workbook. This additional on-task behavior may have enhanced the performance of subjects who worked by themselves.

Another explanation for the results found in this study may be due to the nature of the reward structure provided. Subjects in both the cooperative and individual learning conditions were placed in one of three individual reward structures (i.e.: task, performance, none). Even subjects in the no reward conditions had some incentive for individual learning, because they were told that the lesson would increase success in the course. None of the subjects in the cooperative groups were placed in a cooperative reward structure. Slavin's (1991), suggestion that group rewards have a strong impact on cooperative learning in classroom settings may also be legitimate when cooperative groups use media that were originally designed for individual learning.

Future research should continue to explore the use of cooperative learning with technologies that were originally developed for individual learning. Studies should investigate how different reward structures (e.g., individual, cooperative, competitive) influence outcomes in educational technology settings. Research should also be conducted to examine how students can be taught to cooperate together when they use media. These studies should examine the quantity and quality of group interaction when cooperative strategies are implemented with media. These suggestions will assist us in determining the appropriate use of cooperative learning.

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Title:

Effects of Cooperative Learning and Type of Reward on Performance and Continuing Motivation

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Abstract

The purpose of this study was to investigate the effect of cooperative learning and type of reward on performance and continuing motivation. Subjects used either a cooperative or individual learning strategy while receiving information, examples, practice, and feedback from an instructional television lesson. Subjects were also provided with one of three rewards (i.e.: task, performance, none). Results indicated that subjects who worked alone performed better on the posttest and expressed more continuing motivation than those who worked cooperatively. Type of reward did not affect performance or continuing motivation. Implications for employing cooperative groups in settings that were originally designed for individual learning are provided.

Effects of Cooperative Learning and Type of Reward on Performance and Continuing Motivation

A number of studies have been conducted to compare cooperative and individual learning strategies. According to Johnson & Johnson (1989), a cooperative learning strategy allows students to work together to increase performance and achieve shared goals; an individual learning strategy requires students to work by themselves to accomplish their own goals. Several reviews of research suggest that cooperative learning affects student performance, productivity, transfer of learning, time on task, and attitude (Johnson & Johnson, 1989; Rysavy & Sales, 1991; Sharan, 1980; Slavin, 1990).

The results of cooperative learning research has inspired instructional technologists to examine how cooperative groups can be implemented with media originally designed for individual learning. Results of studies conducted to investigate cooperative learning and computer-assisted instruction are mixed. Some researchers report that cooperative learning positively affected performance in CAI lessons (Dalton, Hannafin, & Hooper, 1989; Johnson, Johnson, & Stanne, 1985), while others have not found a significant effect for performance when learners used cooperative CAI (Carrier & Sales, 1987). Research on cooperative learning and instructional television suggests that students working in groups are more motivated than those who work alone, but performance in these settings is influenced by one's affiliation motives (Klein & Pridemore, 1992).

The mixed results in studies that have examined cooperative learning with media may be due to the rewards provided to students. Some scholars indicate that providing rewards to students who work in cooperative groups can negatively impact their achievement, interest, and continuing motivation (Kohn, 1991). However, many researchers suggest that providing rewards to students is an important component in cooperative learning (Johnson & Johnson, 1989; Sharan, 1980; Slavin; 1990).

Researchers have distinguished between cooperative and individualistic reward structures (Deutsch, 1949; Johnson & Johnson, 1974; Michaels, 1977; Slavin, 1977). A cooperative reward structure provides all members of a group the same reward based on the performance of the whole group. An individualistic reward structure provides each individual with a reward based on their own performance.

In cooperative learning settings, the effect of these types of rewards on performance is unclear. Slavin (1991), suggests ". . . almost every study of cooperative learning in which the cooperative classes achieved more than the traditional control groups used some sort of group reward" (p. 89). However, other researchers have not found cooperative rewards to be superior to individualistic rewards when performance is measured (Hamblin, Hathaway, & Wodarski, 1971; Michaels, 1977; Niehoff & Mesch, 1991). These results may be due to the type of individualistic reward offered to students who work in cooperative groups.

The purpose of the current study was to examine the effect of cooperative learning and type of reward on performance and continuing motivation. The study is a continuation of a program of research designed to investigate how cooperative groups can be implemented with media originally designed for individual learning. While several studies have been conducted to examine cooperative learning and computers, little work has been conducted to examine cooperative learning and instructional television. Adams, Carson, and Hamm (1990) suggest that cooperative learning can influence attention, motivation, and achievement when students use the medium of television. These authors indicate that "cooperative strategies which engage students in examining, comparing, clarifying and evaluating enhance individual experiences" (Adams, Carson, & Hamm, 1990, p. 39).

In this study, subjects used either a cooperative or individual learning strategy while receiving instruction from a television lesson. The independent variables were instructional method (individual versus cooperative) and type of reward (task, performance, none). The dependent variables were performance and continuing motivation.

Method

Subjects

Subjects were 126 undergraduate education majors (30 males, 96 females) in the first semester of a teacher training program at a large southwestern university. All subjects were enrolled in a required course in educational psychology; participation in the study fulfilled a requirement for this course.

Materials

Materials used in this study were an instructional television lesson, a posttest, and a continuing motivation survey.

The instructional television lesson was from the series Instructional Theory: A nine unit mini-course (Gerlach, 1973). The lesson included a videotape and a workbook that provided instruction on the topic of objectives-based assessment. The videotape was approximately 30 minutes in length. It was divided into seven segments which presented information and examples on the content of the lesson. After each segment, the videotape instructed subjects to turn to their workbook for practice and feedback on the content presented in that segment. For example, Segment 4 provided instruction on the use of paper-and-pencil tests, interviews, and observations of student performance or product. After providing information and examples of these three types of objectives-based assessment, the tape presented viewers with three instructors who wished to evaluate a student's work of sculpture. The videotape directed subjects to "Turn to Exercise 4 in your workbook" where they were asked to "Describe the best type of objectives-based assessment for this situation." The workbook then provided written feedback to this practice item on the following page.

Performance was measured using a 15-item, constructed response posttest. The items were developed to evaluate student mastery of the instructional objectives for the lesson on objectives-based assessment. The following is an example of an item on the posttest:

> An industrial technology instructor is teaching his students to adjust a communications receiver so that the sound is of certain minimum quality, at the very least. How should he test for the attainment of this objective?

The maximum score on the posttest was twenty points. Individual answers were checked against a scoring key and points were assigned for each answer. Partial credit was given for questions that required a multiple response such as "List three types of objectives-based assessment." One person scored all of the items on this test. The Kuder-Richardson internal-consistency reliability of the posttest ranges from .69 to .81 (Klein & Pridemore, 1992).

Continuing motivation was assessed using a paper and pencil survey. This survey consisted of seven items that measured the degree to which a subject would want to return to tasks like those used in the study. The directions on this survey indicated,

> Some of the things that you will be learning in the teacher training program will be taught using activities similar to those used in the lesson on objectives-based assessment.

> We are interested in the kinds of activities that you would like to participate in as you continue in the program.

A five-point Likert scale was used to indicate agreement with the statements:

(1) I would like to learn more about objectives-based assessment;

(2) I would like to learn more about objectives-based assessment using instructional television;

(3) I would like to learn more about other topics using instructional television;

(4) I would like to use instructional television programs that require me to work with other students;

(5) I would like to use instructional television programs that require me to work by myself;

(6) I would like to participate in other activities that require me to work with other students;

(7) I would like to participate in other activities that require me to work alone.

The Cronbach alpha internal-consistency reliability estimate of this survey was .60.

Procedures

Subjects were randomly assigned to one of six treatment conditions. All possible combinations of instructional method (individual versus cooperative) and type of reward (task, performance, none) were equally represented after assignment to groups. Additional random assignment was conducted for the cooperative learning treatments; subjects in these conditions were randomly assigned to groups of three (triads).

Each treatment condition was implemented in a separate room; each room had more than one individual or cooperative group present at a time. At the beginning of the lesson, subjects in all treatments were informed that they would be viewing an instructional television program on objectives-based assessment and that they would be using a workbook to receive practice and feedback on the content of the lesson. Subjects were told to write the answer to each practice exercise in the workbook and read the feedback that followed each exercise. In addition, subjects in all groups were directed to read the first two pages of the workbook to receive the lesson objectives and were told that they would each be completing a test on the content of the lesson. Other procedures and directions were different depending on treatment condition.

Subjects received specific directions for implementing either an individual or a cooperative learning strategy. Subjects working alone were each given a workbook, instructed to work independently during the lesson, and told to do their best work. Subjects in the cooperative learning conditions were randomly assigned to a triad. Each triad was given a workbook and told to (a) work together during the lesson, (b) discuss all practice exercises and any disagreements over the answers, and (c) discuss the given feedback.

Subjects also received specific directions concerning the reward for learning depending on their treatment group. Subjects in the task reward groups were told, "Your participation in this lesson is worth ten points toward your course grade." Subjects in the performance reward groups were told, "Your participation in this lesson can be worth as much as ten points, but the number of points you earn depends on how much you learn from the lesson." Finally, subjects in the no reward groups were told, "Your participation in this lesson will help you to be successful both on the final exam and on the course project."

After the above instructions were provided, the videotape was started for each treatment condition. When Segment 1 was completed, the tape was stopped and subjects did Exercise 1. When Exercise 1 was completed, the videotape was started again. This cycle was continued until all seven sections of the lesson were finished.

Upon completion of these activities, all workbooks were collected and each subject individually completed the continuing motivation survey. One week later, all subjects were given the posttest and were required to work individually to complete it. One week after the posttest session, subjects attended a debriefing session where they were informed that each of them would earn ten points toward their course grade regardless of how well they performed on the lesson posttest.

Design and Data Analysis

A 2 X 3 factorial design was used, with instructional method (individual versus cooperative) and type of reward (task, performance, none) as the independent variables. The dependent variables were performance and continuing motivation. Analysis of variance (ANOVA) was used to test for a difference between groups on the posttest. Multiple analysis of variance (MANOVA) was used to test for an overall difference between groups on the continuing motivation survey. This analysis was followed by univariate analyses on the individual survey items. Alpha was set at .05 for all statistical tests. Effect size estimates (ES) expressed as a function of the overall standard deviation were also calculated. Data for 125 out of the 126 subjects were included in the analyses, since data for one subject was incomplete.

Results

Performance

Performance was measured using the 15-item, constructed response posttest. Mean scores and standard deviations for the posttest can be found in Table 1.

Table 1 about here

Analysis of variance (ANOVA) revealed that type of instructional method had a significant effect on performance, $F(1, 119) = 4.07$, $p < .05$, $MSe = 13.76$, $ES = .34$. Subjects who worked alone performed better on the posttest (M = 11.9, SD = 3.7) than those who worked cooperatively (M = 10.6, SD = 3.6). Type of reward did not have a significant effect on performance. Furthermore, a significant interaction between instructional method and type of reward was not found.

Continuing Motivation

Continuing motivation was measured using the seven-item scale. Mean scores and standard deviations for individual continuing motivation items can be found in Table 2.

Table 2 about here

Multiple analysis of variance (MANOVA) suggested that type of instructional method had a significant effect on continuing motivation, $F(7, 113) = 4.10$, $p < .001$. Type of reward did not affect continuing motivation and a significant interaction between instructional method and type of reward was not found.

Univariate analyses revealed that subjects who worked alone expressed more continuing motivation than those who worked cooperatively for instructional television programs that require individual work, $F(1,119) = 16.23$, $p < .001$, MSe = 1.34, ES = .69, and for other activities that require individual work, $F(1,119) = 7.50$, $p < .01$, MSe = 1.44, ES = .48. In addition, subjects who worked cooperatively expressed more continuing motivation than those who worked alone for activities that require working with other students, $\underline{F}(1,119) = 5.82$, $\underline{p} < .05$, $\underline{MSe} = .94$, $\underline{ES} = .42$.

Discussion

The purpose of this study was to explore the effect of cooperative learning and type of reward on performance and continuing motivation. Subjects used either a cooperative or individual learning strategy while receiving information, examples, practice, and feedback from an instructional television lesson.

Results indicated that subjects who worked alone performed better and expressed more continuing motivation than those who worked cooperatively. These findings lend support to other studies which suggest that a cooperative strategy may not affect educational outcomes in some settings. While cooperative learning has influenced student performance and attitudes in classroom settings (Johnson & Johnson, 1989; Sharan, 1980; Slavin, 1990), cooperative learning has not always influenced performance when it is implemented with media originally designed for individual learning (Carrier & Sales, 1987; Klein & Pridemore, 1992).

The results of the current study may have occurred because of how students approach learning from instructional television lessons. In our society, television viewing is an individual experience with little opportunity for interaction among viewers. Furthermore, television is typically implemented for individual use in instruction. Most students have very little practice working with other people when using instructional television lessons.

Even though subjects in the triads were given specific directions for implementing a cooperative strategy during the lesson, informal observations suggest that many groups did not follow these directions. After each segment of the tape was stopped, subjects in several of the triads quietly read the question in the workbook to themselves. One of the group members would usually ask the others for the answer and would write it in the workbook. Very little on-task discussion occurred in these groups. Groups that finished the practice before other triads in the room would usually talk about topics that were unrelated to the lesson. These behaviors are somewhat different than those of the subjects who worked alone. After reading the each question and answering it, many individuals who finished the practice before others in the room usually reviewed the item or looked ahead to the next item in their workbook. This additional on-task behavior may have enhanced the performance of subjects who worked by themselves.

Another explanation for the results found in this study may be due to the nature of the reward structure provided. Subjects in both the cooperative and individual learning conditions were placed in one of three individual reward structures (i.e.: task, performance, none). Even subjects in the no reward conditions had some incentive for individual learning, because they were held that the lesson would increase success in the course. None of the subjects in the cooperative groups were placed in a cooperative reward structure. Slavin's (1991), suggestion that group rewards have a strong impact on cooperative learning in classroom settings may also be legitimate when cooperative groups use media that were originally designed for individual learning.

This study has some implications for those who design instruction. Educators should implement specific instructional elements (e.g., practice, feedback, review) when they present information via television lessons. Each student should be given the opportunity to receive these elements during a televised lesson. Furthermore, practitioners who wish to employ cooperative learning strategies with media such as CAI or television should provide each group an opportunity to practice working with others before assessing their performance. Finally, educators should provide appropriate rewards to promote group interaction and on-task behavior in all cooperative learning settings.

Future research should continue to explore the use of cooperative learning with technologies that were originally developed for individual learning. Studies should investigate how different reward structures (e.g., individual, cooperative, competitive) influence outcomes in educational technology settings. Research should also be conducted to examine how students can be taught to cooperate together when they use media. These studies should examine the quantity and quality of group interaction when cooperative strategies are implemented with media. These suggestions will assist us in determining the appropriate use of cooperative learning.

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Table 1

Mean Scores and Standard Deviations on Performance Test

	Type of Reward			
Condition	Task	Performance	None	Total
Individual Learning	11.5	11.6	12.5	11.9
	(3.2)	(3.9)	(4.2)	(3.7)
Cooperative Learning	9.9	11.6	10.0	10.6
	(3.0)	(3.8)	(3.9)	(3.6)
Total	10.7	11.6	11.3	11.2
	(3.2)	(3.8)	(4.2)	(3.8)

Note: Maximum possible score = 20;

Table 2

Mean Scores and Standard Deviations for Continuing Motivation

	Group		
Item*	Individual	Cooperative	Total
Question 1	3.99	3.73	3.86
	(0.86)	(1.07)	(0.98)
Question 2	2.61	2.29	2.45
	(1.18)	(1.11)	(1.15)
Question 3	2.79	2.43	2.61
	(1.18)	(1.17)	(1.18)
Question 4	2.61	2.95	2.78
	(1.21)	(1.40)	(1.31)
Question 5	2.69	1.86	2.27
	(1.28)	(1.00)	(1.21)
Question 6	3.60	4.02	3.81
	(1.06)	(0.87)	(0.99)
Question 7	3.16	2.57	2.86
	(1.19)	(1.19)	(1.22)

*Specific item description are found in text.

Title:

Channel One: Reactions of Students, Teachers and Parents

Author:

Nancy Nelson Knupfer

572

CHANNEL ONE: REACTIONS OF STUDENTS, TEACHERS AND PARENTS

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In the flurry of activity surrounding contractual agreements and installation of equipment to support the Channel One news broadcast, many people have neglected to ask critical questions concerning the implementation of this innovative educational program. The program is designed to be used as a complete, twelve-minute broadcast, but the literature on educational media contains ample evidence showing that teachers frequently use only specified parts of media products rather than entire sequences as they are packaged (Cambre, 1987). Past experience demonstrates that rushing to place technology in schools without adequate planning can lead to failure of an innovation (Cuban, 1986; Fullan and Pomfret, 1977; Goodlad, 1975; Knupfer, 1988; Rogers, 1983). Like any other educational tool, the success of Channel One will not rest solely within the product itself but will depend upon how it is received by the key people who use it and the way in which it is implemented.

It follows then, that some key questions need to be addressed such as: Does Channel One offer a product that is worthwhile? Is it answering a need in the curriculum? How do the teachers implement the 12-minute news show? What are teachers doing to reinforce the news teaching and to teach critical viewing of advertisements? In order to determine the answers to these questions, it is important to investigate how Channel One is being utilized within schools and what the parents, teachers, and students think of it.

The purpose of this study was to examine how students, teachers, and parents reacted to the Channel One news broadcast initially and after experience with the program. Students, teachers, and parents in three school districts were surveyed to gather information about how the news broadcast was initiated in their school, how it was implemented, what they thought about Channel One, and their habits concerning news consumerism.

These groups were surveyed twice; once at the beginning of their experience with Channel One and once at the end of the school year to see if their opinions of the broadcast or their news-related activities changed after experience with the broadcast. Spot checks were done in the form of interviews and classroom observations to see how the broadcast was being implemented and if it had any effect on students' interest in the news.

RESEARCH QUESTIONS

1. Were decisions to adopt Channel One based on curriculum support?
2. Were decisions to adopt Channel One based on opportunism?
3. Who made the decision to adopt Channel One?
4. What factors most influenced the decision to adopt Channel One?
5. How has the broadcast time been accommodated within the schedule of the school day?
6. How are teachers implementing the content of Channel One?
7. What are the opinions of teachers, students, and parents upon initial introduction to Channel One and after experience with the program?
8. Do senior high school students react any differently to Channel One than do junior high students?

METHODOLOGY

Subjects

A sample of high schools and junior high schools was selected based upon which schools in three districts received the Channel One broadcast. All schools that received the broadcast within the three chosen districts were surveyed; this included eight high schools and seven junior high schools.

Cooperation of the administration was secured to provide for smooth distribution and collection of survey instruments. It was hoped that this strategy would provide the best return rate.

Subjects included 581 teachers, 2457 students, and 652 parents from junior high and high school within three different school districts. The subjects were selected randomly within each school.

Materials and Method

Three sets of written survey instruments were developed for use with the teachers, students, and parents respectively. Each instrument contained questions that were measured on a five-point

Likert-type scale as well as open-ended questions intended to draw out more information.

Each group was surveyed twice, once after two weeks of experience with the Channel One broadcast and again two weeks prior to the end of the school year. Each set of survey instruments for the parents and students remained identical between the pre and post experience. The post survey instrument used for the teachers was slightly different from that used in the pre survey.

Surveys were distributed to school principals who, in turn, requested the cooperation of the teachers in gathering the data. Students surveys were distributed to entire classes of students and collected immediately upon completion. Students who were surveyed were asked to take a survey instrument home to their parents. Return rates were one hundred percent for students, about 95% for teachers, and about 25% for parents.

Analysis

Data analysis was conducted with summary and nonparametric statistics. These allowed accurate comparisons to be made and visually diagrammed for presentation. Information collected by interview was analyzed qualitatively.

RESULTS & CONCLUSIONS

The decision to adopt Channel One was based on opportunism rather than on curricular content or a specific curricular need. Schools were interested in receiving something at a low cost, and personnel were especially excited about the possibility of receiving equipment and cabling. In some cases teachers were disappointed because the equipment configuration prevented them from doing the type of activity that they had envisioned.

In each district, the superintendent or the superintendent along with the school board made the decision to allow Channel One within the district. Each superintendent then allowed the final decision to be made by the individual school principals. Some of the principals consulted with the teachers and others did not.

The teachers had little investment and did not seem concerned about making a serious effort to implement the broadcast in a meaningful way. Those teachers who were involved in the decision to adopt Channel One seemed to be making a better effort to make it successful than those who were not consulted prior to implementation. In some schools the staff believed that the real value of Channel One was not in learning about the news, but instead was related to the outgrowth of activities attributed to the Channel One broadcast. For example, some schools used the system for school announcements, one school started its own within-school news program, and another one extended that idea outside of the school to support community events.

The twelve minutes of time was handled in various ways but all schools tried to implement the program in a way that did not subtract time from existing subjects. One district added twelve minutes to the school day for each school using Channel One. The other two districts provided the twelve minutes by a combination of shortening passing time between classes, shortening lunch period, or using homeroom time for the Channel One broadcast.

In general, students at the junior high level liked the broadcast more than did the high school students. Teachers had a more favorable assessment of the broadcast than did the students. Parents did not seem to know much about the broadcast. More parents responded to the second round of the survey which suggests that more parents became more aware of Channel One or possibility more attentive to Channel One issues during the school year.

In most cases, Channel One was implemented as a stand-alone topic rather than in accordance with curricular goals. There appeared to be little class time devoted to preparing the students for the broadcast or for discussions following the broadcast. Students' attention to and involvement with reading newspapers did not seem to increase over the course of the school year, but students appear to watch television news more frequently.

The attached graphics represent the percentage of respondents that agreed or strongly agreed with each listed topic. It is evident from the graphics that initially about 70% of teachers and 50% of students agreed that Channel One was easier to understand than other television news broadcasts, and each of those percentages increased by approximately 5% after experience with the broadcast. After experiencing the broadcast, a higher percentage of students and parents believed that advertisements can have too much influence on students; teachers were the opposite.

In general, as teachers and students gained experience with Channel One they were less inclined to believe that it teaches critical consumerism. When asked if the product is a very good quality teaching tool, teachers were the more enthusiastic than parents and students, and more of teachers agreed with this statement after experience with the product; students and parents were the opposite. In response to a query about whether their school should continue Channel One, teachers and high school students seemed to lose some interest while junior high students gained enthusiasm for the broadcast during the schoolyear; a clear majority of all groups agreed that their school should continue.

In the interest of saving space in this publication, I will not discuss each of the graphics, but I shall attach selected graphics along with samples of the written survey instruments for the reader to study.

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DEMOGRAPHICS

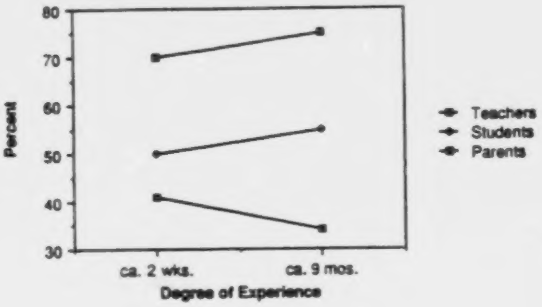
Round One

	Teachers	Students	Parents
Junior High	275 of 280	1105	58
High School	306 of 320	1322	82
TOTAL	581	2427	140

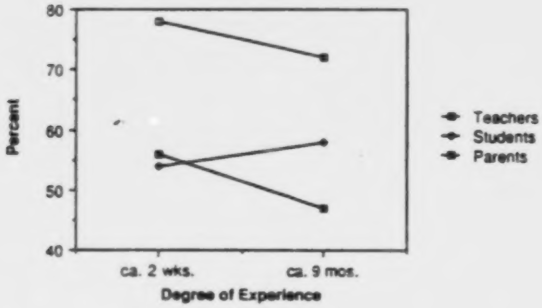
Round Two

	Teachers	Students	Parents
Junior High	272 of 280	1118	316
Senior High	301 of 320	1339	336
TOTAL	573	2457	652

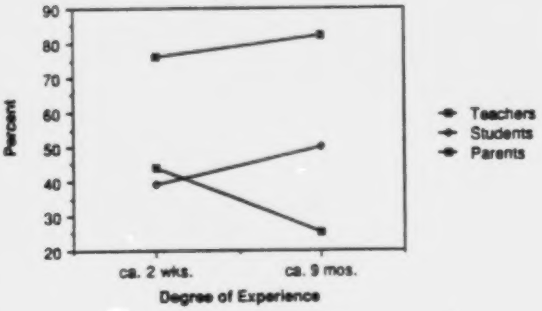
Easier to Understand than Other TV News



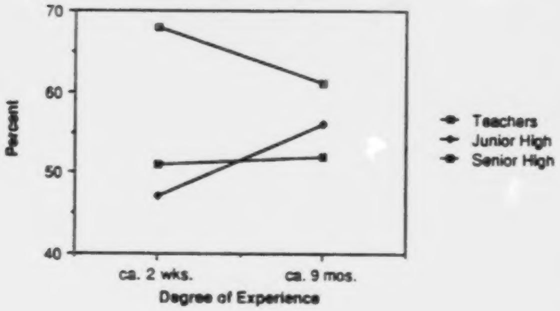
Teaches Current Events Very Well



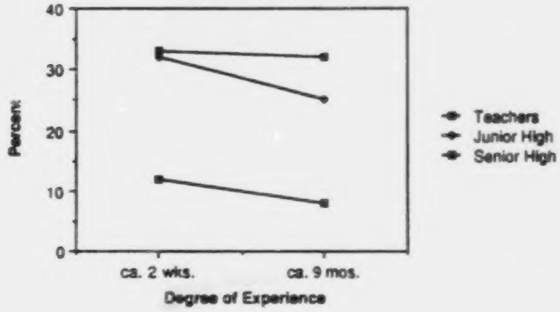
Teaches Geography Very Well



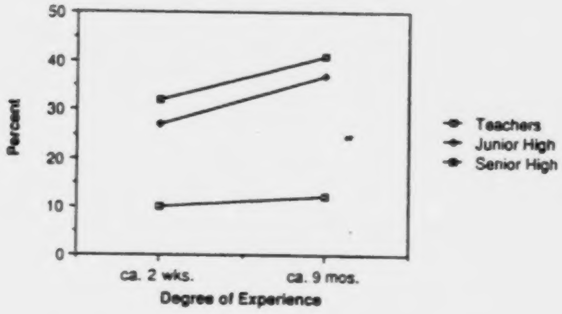
Students Learn a Lot

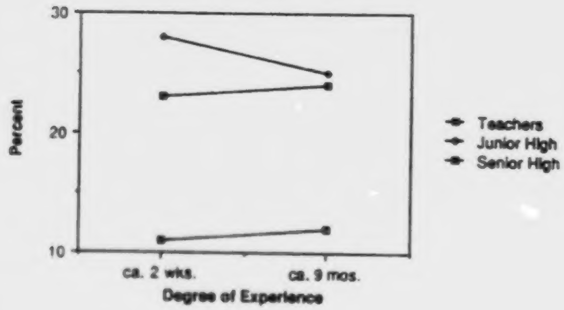


Students Seem Bored

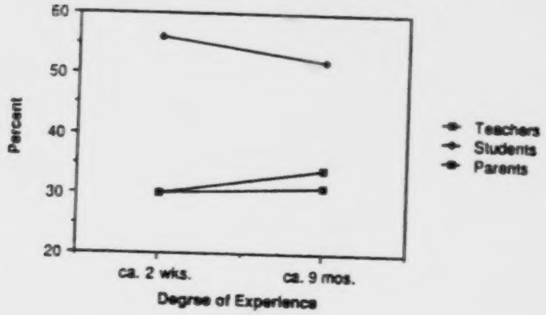


Channel One is Too Simple

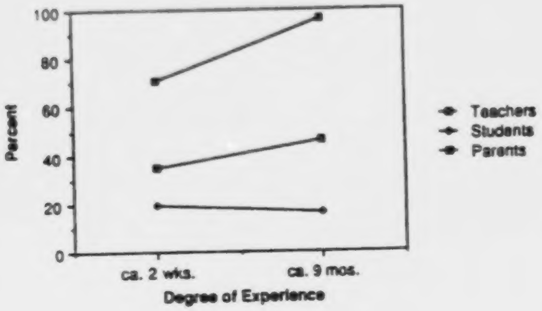




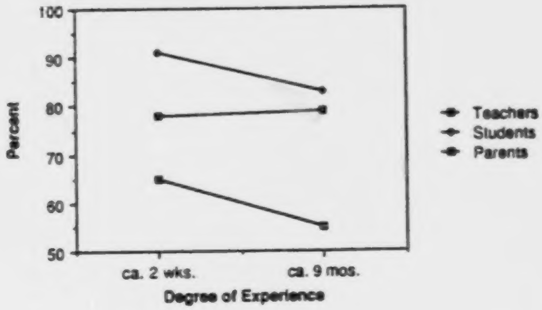
Too Complex for Short Time



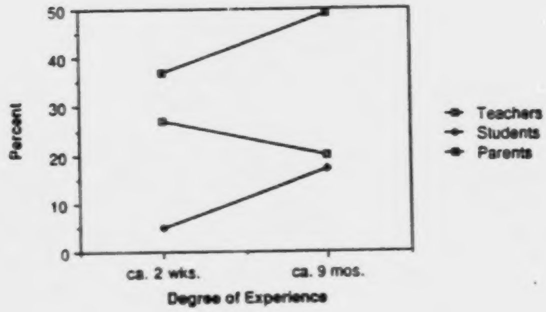
Encourages Thinking About the News



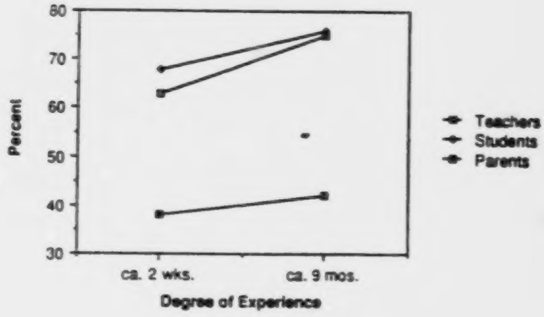
Discuss Ads



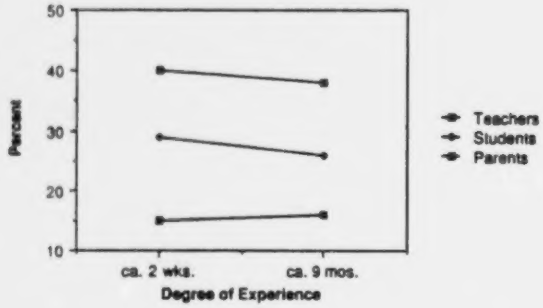
Not Convinced it Teaches Critical Consumerism



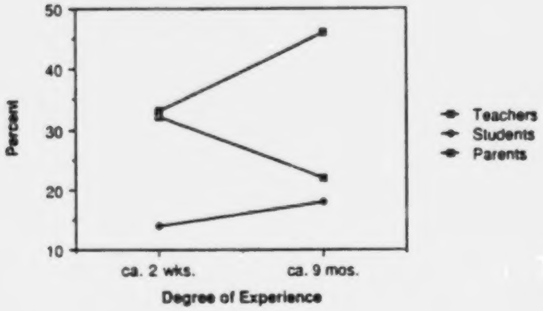
Ads Have Too Much Influence



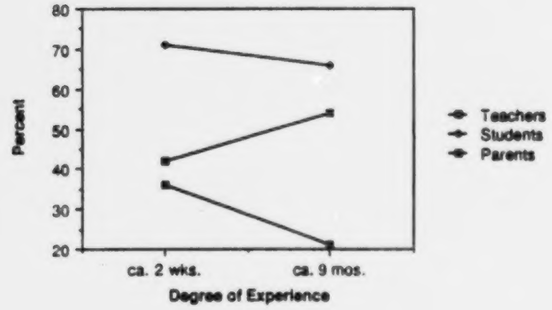
Ads Same as Those on TV



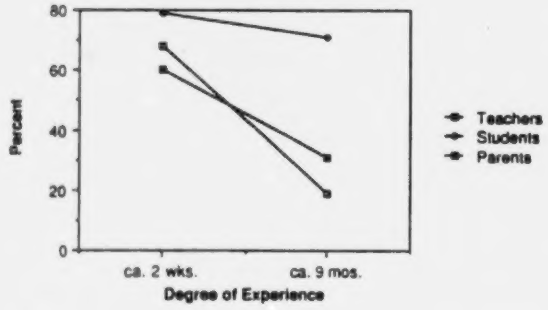
Ads are Pretty Truthful



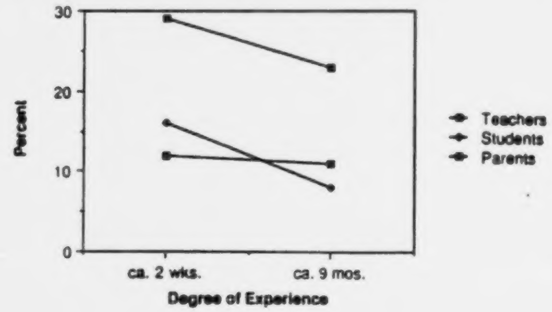
Ads Don't Belong in School



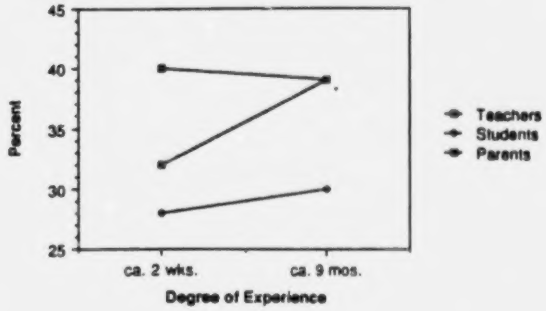
Nothing Wrong with Ads in School



Ads in School are OK

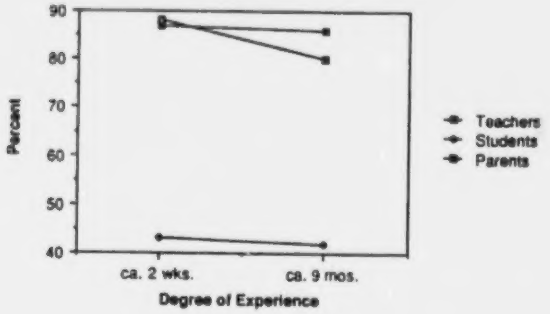


Causes Students to Read More News Magazines

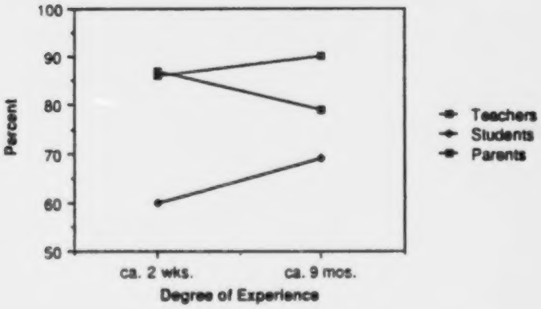


Read News Magazines at Least 3 Times Weekly

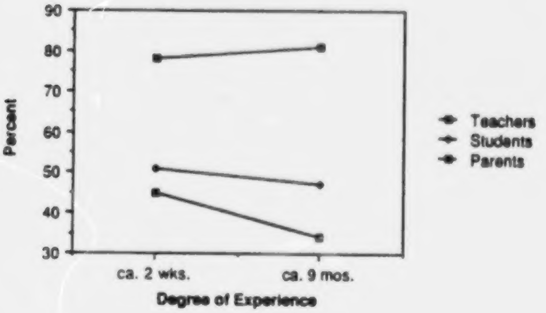
Read Newspaper At Least 3 Times Weekly



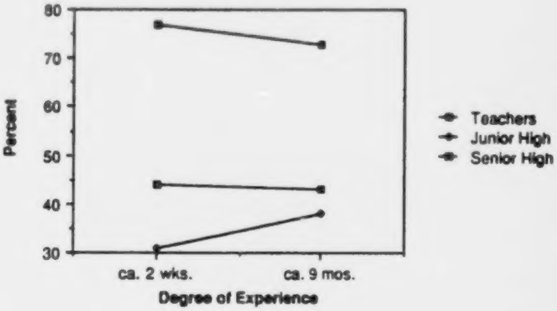
Watch News at Least 3 Times Per Week



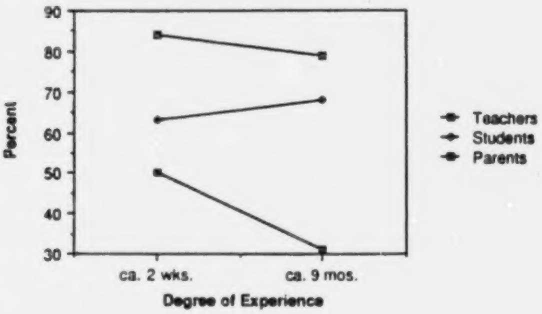
Very Good Quality Teaching Tool



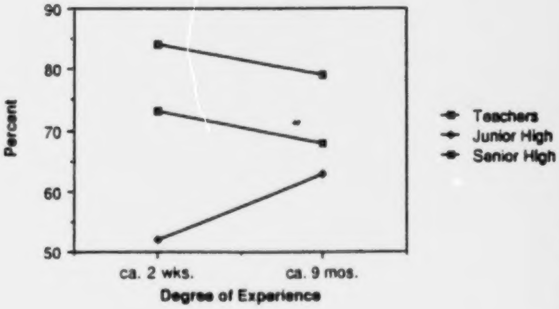
I Like Channel One a Lot



School Should Continue Channel One



Should Continue Channel One



BEST COPY AVAILABLE

Channel One News Survey for Teachers

School ____________ Name (optional)____________ Your Grade or Subject _____ Gender_____ Years Teaching _____ Date PRE _____

Circle a number for each statement below.
The News:

		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1	Is a very good quality teaching tool.	1	2	3	4	5
2	Is accurate.	1	2	3	4	5
3	Covers the most important issues.	1	2	3	4	5
4	Covers the same topics as national daily news programs.	1	2	3	4	5
5	Is too fast-paced for the students.	1	2	3	4	5
6	Is too slow for the students.	1	2	3	4	5
7	Is just the right pace.	1	2	3	4	5
8	Is too simple for my students.	1	2	3	4	5
9	Is too complex to cover in such a short time.	1	2	3	4	5
10	I like Channel One news a lot.	1	2	3	4	5
11	Our school should continue to view Channel One news.	1	2	3	4	5
12	Students learn a lot from Channel One news.	1	2	3	4	5
13	Students remember a lot about the news.	1	2	3	4	5
14	The supplementary materials are excellent.	1	2	3	4	5

In any week, how often do you:

		Never	1-2 Times	3-4 Times	5-6 Times	Every Day
1	Watch the news on TV at home?	1	2	3	4	5
2	Read the newspaper?	1	2	3	4	5
3	Read news magazines?	1	2	3	4	5

In any week, how often do you do the following in conjunction with Channel One?

		Never	1 Times	2 Times	3 Times	4-5 Times
1	Use the provided supplementary materials.	1	2	3	4	5
2	Discuss the news after we view it.	1	2	3	4	5
3	Discuss cause and effect relationships with students.	1	2	3	4	5
4	Use Channel One to teach critical consumerism.	1	2	3	4	5
5	Discuss fact versus propaganda.	1	2	3	4	5
6	Discuss predicting outcomes with students.	1	2	3	4	5
7	Classroom discussions lead to extended activities.	1	2	3	4	5
8	I have time to prepare a good lesson to use with Chan.1.	1	2	3	4	5
9	I have time in the school day to do follow-up activities.	1	2	3	4	5

Channel One:

		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1.	Is easier for students to understand than other TV news.	1	2	3	4	5
2.	Is sensitive to multi-cultural issues.	1	2	3	4	5
3.	Helps students become culturally literate.	1	2	3	4	5
4.	Helps students become better citizens.	1	2	3	4	5
5.	Teaches students about our government.	1	2	3	4	5
6.	Teaches students about health.	1	2	3	4	5
7.	Teaches students to be critical consumers.	1	2	3	4	5
8.	Helps students see cause and effect relationships.	1	2	3	4	5
9.	Is effective for teaching about international events.	1	2	3	4	5
10.	Is effective for teaching about national events.	1	2	3	4	5
11.	Is effective for teaching about local events.	1	2	3	4	5
12.	Helps students become critical thinkers.	1	2	3	4	5
13.	Leads students to read more news magazines.	1	2	3	4	5
14.	Leads students to read more newspapers.	1	2	3	4	5
15.	Answers a need in the curriculum.	1	2	3	4	5
16.	Teaches current events very well.	1	2	3	4	5
17.	Teaches geography very well.	1	2	3	4	5
18.	Is a very valuable educational tool.	1	2	3	4	5
19.	Is boring to the students.	1	2	3	4	5
20.	Holds the close attention of most students.	1	2	3	4	5
21.	Lightens my workload.	1	2	3	4	5
22.	Increases my workload.	1	2	3	4	5
23.	Channel One promotes follow-up discussion/activities.	1	2	3	4	5
24.	Channel One can stand alone with no discussion.	1	2	3	4	5

What percentage of your class:

1. Pays close attention to the news? _____%
2. Pays close attention to the advertisements? _____%
3. Is actively involved with discussions? _____%

Which students seem to benefit most from using Channel One?

_____ Remedial/At Risk _____ Average _____ Above Average _____ Other, please explain

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Knupfer, Chan One p. 11

The Advertising:	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1. Does not belong in schools.	1	2	3	4	5
2. Can have too much influence on students.	1	2	3	4	5
3. Is pretty truthful about the product.	1	2	3	4	5
4. Pressures students to buy products like others have.	1	2	3	4	5
5. Our classroom discusses the advertisements.	1	2	3	4	5
6. Channel One ads are like the ads shown on regular TV.	1	2	3	4	5
7. Students seem to like the ads better than the news.	1	2	3	4	5
8. Students remember the advertising more than the news.	1	2	3	4	5
9. There is nothing wrong with watching ads in school.	1	2	3	4	5
10. I see ads in other places in school, not just Channel One.	1	2	3	4	5

Write a brief explanation for each following question.

1. What problems could arise out of showing advertisements in schools?

2. Do you think it is okay to show advertisements in school? Why or why not?

3. Check all who were involved in making the decision to implement Channel One?

____ Superintendent ____ School Board ____ Principal ____ Teachers ____ Parents ____Students

4. What **factors** influenced that decision?

5. Why do you think Channel One has caused such a **controversy**? Please explain.

6. In your opinion, what is the **key issue** that educators should be concerned about?

7. Are you attempting to fit the program **into the curriculum** or is it being used as a **stand-alone topic**? (check 1)

_____ Fit into curriculum. HOW?____

_____ Stand-alone topic

8. What usually happens in your classroom after the Channel One broadcast is over?

9. How has your school accommodated the extra 12 minutes to view Channel One news? If there has been any change in daily schedule, how do you feel about it?

Channel One News Survey for Teachers

School ________________ Name (optional)____ ____________ Your Grade or Subject _____ Gender_____ Years Teaching _____ Date POST

Circle a number for each statement below.

The News:

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1 Is a very good quality teaching tool.	1	2	3	4	5
2 Is accurate	1	2	3	4	5
3 Covers the most important issues.	1	2	3	4	5
4 Covers the same topics as national daily news programs.	1	2	3	4	5
5 Is too fast-paced for the students.	1	2	3	4	5
6 Is too slow for the students.	1	2	3	4	5
7 Is just the right pace.	1	2	3	4	5
8 Is too simple for my students.	1	2	3	4	5
9 Is too complex to cover in such a short time.	1	2	3	4	5
10 I like Channel One news a lot.	1	2	3	4	5
11 Our school should continue to view Channel One news.	1	2	3	4	5
12 Students learn a lot from Channel One news.	1	2	3	4	5
13. Students remember a lot about the news.	1	2	3	4	5
14 The supplementary materials are excellent.	1	2	3	4	5

In any week, how often do you:

	Never	1-2 Times	3-4 Times	5-6 Times	Every Day
1 Watch the news on TV at home?	1	2	3	4	5
2 Read the newspaper?	1	2	3	4	5
3 Read news magazines?	1	2	3	4	5

In any week, how often do you do the following in conjunction with Channel One?

	Never	1 Times	2 Times	3 Times	4-5 Times
1 Use the provided supplementary materials.	1	2	3	4	5
2 Discuss the news after we view it.	1	2	3	4	5
3 Discuss cause and effect relationships with students.	1	2	3	4	5
4 Use Channel One to teach critical consumerism.	1	2	3	4	5
5 Discuss fact versus propaganda.	1	2	3	4	5
6 Discuss predicting outcomes with students.	1	2	3	4	5
7 Classroom discussions lead to extended activities.	1	2	3	4	5
8 I have time to prepare a good lesson to use with Chan.1.	1	2	3	4	5
9 I have time in the school day to do follow-up activities.	1	2	3	4	5

Channel One:

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1. Is easier for students to understand than other TV news.	1	2	3	4	5
2. Is sensitive to multi-cultural issues.	1	2	3	4	5
3. Helps students become culturally literate.	1	2	3	4	5
4. Helps students become better citizens.	1	2	3	4	5
5. Teaches students about our government.	1	2	3	4	5
6. Teaches students about health.	1	2	3	4	5
7. Teaches students to be critical consumers.	1	2	3	4	5
8. Helps students see cause and effect relationships.	1	2	3	4	5
9. Is effective for teaching about international events.	1	2	3	4	5
10. Is effective for teaching about national events.	1	2	3	4	5
11. Is effective for teaching about local events.	1	2	3	4	5
12. Helps students become critical thinkers.	1	2	3	4	5
13. Leads students to read more news magazines.	1	2	3	4	5
14. Leads students to read more newspapers.	1	2	3	4	5
15. Answers a need in the curriculum.	1	2	3	4	5
16. Teaches current events very well.	1	2	3	4	5
17. Teaches geography very well.	1	2	3	4	5
18. Is a very valuable educational tool.	1	2	3	4	5
19. Is boring to the students.	1	2	3	4	5
20. Holds the close attention of most students.	1	2	3	4	5
21. Lightens my workload.	1	2	3	4	5
22. Increases my workload.	1	2	3	4	5
23. Channel One promotes follow-up discussion/activities.	1	2	3	4	5
24. Channel One can stand alone with no discussion.	1	2	3	4	5

What percentage of your class:
1. Pays close attention to the news? ____%
2. Pays close attention to the advertisements? ____%
3. Is actively involved with discussions? ____%

Which students seem to benefit most from using Channel One?
_____ Remedial/At Risk _____ Average _____ Above Average _____ Other, please explain

TURN THIS PAGE OVER AND FILL IN THE BACK

Knupfer, Chan One p. 13

The Advertising:	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1. Does not belong in schools.	1	2	3	4	5
2. Can have too much influence on students.	1	2	3	4	5
3. Is pretty truthful about the product.	1	2	3	4	5
4. Pressures students to buy products like others have.	1	2	3	4	5
5. Our classroom discusses the advertisements.	1	2	3	4	5
6. Channel One ads are like the ads shown on regular TV.	1	2	3	4	5
7. Students seem to like the ads better than the news.	1	2	3	4	5
8. Students remember the advertising more than the news.	1	2	3	4	5
9. There is nothing wrong with watching ads in school.	1	2	3	4	5
10. I see ads in other places in school, not just Channel One.	1	2	3	4	5

Write a brief explanation for each following question.

1. Describe your school's experience with Channel One this year.
   In general?

   Problems?

   Successes?

   Inspirations?

2. Has the showing of advertisements in school caused any problems or concerns? (Check one) ☐ NO ☐ YES
   Why or why not?

3. Are you attempting to fit the program **into the curriculum** or is it being used as a **stand-alone topic?**(check 1)

   _____ Fit into curriculum. HOW?______________________________

   _____ Stand-alone topic

4. What usually happens in your classroom after the Channel One broadcast is over?

5. Are any particular teachers responsible for discussing the news with students after viewing? Please explain.

Channel One News Survey School ____________________ Student Number__________________ Grade Level ______ Date_____________

What do you think about the NEWS? Circle a number for each statement below.

The News:	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1 Coverage seems complete.	1	2	3	4	5
2 Is accurate.	1	2	3	4	5
3 Covers the most important issues.	1	2	3	4	5
4. Covers the same topics as regular daily news programs.	1	2	3	4	5
5 Is better than the local evening news.	1	2	3	4	5
6 Is better than the national evening news.	1	2	3	4	5
7 Is too fast	1	2	3	4	5
[illegible] too slow	1	2	3	4	5
[illegible] just the right pace.	1	2	3	4	5
10 Is too simple.	1	2	3	4	5
11 Is too complex to cover in such a short time.	1	2	3	4	5
12 The news seems more important than the ads.	1	2	3	4	5
13 I like the news better than the advertising	1	2	3	4	5
14 Channel One has taught me a lot about current events.	1	2	3	4	5
15 Channel One has taught me where places are in the world.	1	2	3	4	5
16 Channel One is a good way to learn about the news.	1	2	3	4	5
17 Channel One is boring	1	2	3	4	5
18 I usually watch Channel One but do not listen.	1	2	3	4	5
19 I usually listen to Channel One but do not watch it.	1	2	3	4	5
20 I often do not pay attention to the Channel One program.	1	2	3	4	5
21 I like Channel One news a lot.	1	2	3	4	5
22 Our school should continue to view Channel One news.	1	2	3	4	5
23 I have learned a lot from Channel One news.	1	2	3	4	5
24 Channel One causes me to think more about the news.	1	2	3	4	5
25 Our class usually discusses the news after we view it.	1	2	3	4	5
26 Channel One is easier to understand than other TV news.	1	2	3	4	5
27 The quality of news is very good.	1	2	3	4	5

What do you think about the ADS? Circle a number for each statement below.

The Advertising:	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1. Does not belong in schools.	1	2	3	4	5
2. Is a form of propaganda that can influence people.	1	2	3	4	5
3. Can have too much influence on students.	1	2	3	4	5
4. Influences what I buy.	1	2	3	4	5
5. Is pretty truthful about the product.	1	2	3	4	5
6. Generally stretches the truth about a product's worth.	1	2	3	4	5
7. Pressures me to buy products like other students have.	1	2	3	4	5
8. Is not to be trusted.	1	2	3	4	5
9. Our classroom discusses the advertisements.	1	2	3	4	5
10. Channel One ads are like the ads shown on regular TV.	1	2	3	4	5
11. Channel One ads are better than regular TV advertising.	1	2	3	4	5
12. Our class is taught to be critical of advertisements.	1	2	3	4	5
13. The advertising seems more important than the news.	1	2	3	4	5
14. I like the advertising better than the news.	1	2	3	4	5
15. I remember the advertising more than the news.	1	2	3	4	5
16. There is nothing wrong with watching ads in school.	1	2	3	4	5
17. I see ads in other places in school, not just Channel One.	1	2	3	4	5

In any week:	Never	1-2 Times	3-4 Times	5-6 Times	Every Day
1. How often do you watch the news on TV at home?	1	2	3	4	5
2. How often do you read the newspaper?	1	2	3	4	5
3. How often do you read news magazines?	1	2	3	4	5

4. Has Channel One caused you to read more news magazines? YES or NO (circle 1)

5. When you do watch news, which news do you watch at home? LOCAL or NATIONAL (circle 1)

6. What is your ethnic origin? (check one)
_____Asian _____Black _____Hispanic _____Native American _____White

7. How much money do you usually spend per week?__________________dollars

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What is your gender? (check one) ____Male ____Female

Write a brief explanation for each question below.

1. What problems could arise out of showing advertisements in schools?

2. Do you think it is okay to show advertisements in school? Why or why not?

3. From yesterday's Channel One news show , name 3 news stories and tell why they are important.

    (1)

    (2)

    (3)

4. From yesterday's Channel One news show , name and describe 3 advertisements that you remember the most.

    (1)

    (2)

    (3)

5. List the news magazines that you read regularly.

6. Which parts of the newspaper do you read?

7. What usually happens in your classroom after the Channel One broadcast is over?

Channel One News Survey for Parents

School ______________________ Name (optional)__________________ Date______________

Your Occupation ________________ Gender__________________________ Age_______________

Circle a number for each statement below.

	Yes	No
1. Have you heard of Channel One news before?	1	2
2. Have you seen any of the Channel One programs?	1	2

Channel One News:

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1. Is easier for students to understand than other TV news.	1	2	3	4	5
2. Helps students become culturally literate.	1	2	3	4	5
3. Helps students become better citizens.	1	2	3	4	5
4. Teaches students about our government.	1	2	3	4	5
5. Teaches students about health.	1	2	3	4	5
6. Teaches students to be critical consumers.	1	2	3	4	5
7. Helps students become critical thinkers.	1	2	3	4	5
8. Leads students to read more news magazines.	1	2	3	4	5
9. Leads students to read more newspapers.	1	2	3	4	5
10. Answers a need in the curriculum.	1	2	3	4	5
11. Teaches current events very well.	1	2	3	4	5
12. Teaches geography very well.	1	2	3	4	5
13. Is a very good quality teaching tool.	1	2	3	4	5
14. Students learn a lot from Channel One news.	1	2	3	4	5
15. Channel One news is a good addition to the school curriculum.	1	2	3	4	5
16. I want my child to view Channel One news.	1	2	3	4	5
17. Students who view Channel One news will have an educational advantage over those who don't view.	1	2	3	4	5
18. Channel One dictates school curriculum and should not be allowed.	1	2	3	4	5

The Advertising:

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1. Does not belong in schools.	1	2	3	4	5
2. Can have too much influence on students.	1	2	3	4	5
3. Is usually pretty truthful about the products.	1	2	3	4	5
4. Pressures students to buy products like others have.	1	2	3	4	5
5. Channel One ads are like the ads shown on regular TV.	1	2	3	4	5
6. There is nothing wrong with watching ads in school.	1	2	3	4	5
7. I see ads in other places in school, not just Channel One.	1	2	3	4	5
8. Teenagers are gullible and should not be view ads in school.	1	2	3	4	5
9. Advertising to teenagers in school should not be allowed.	1	2	3	4	5
10. The benefits of Channel One news outweigh the disadvantages of advertising.	1	2	3	4	5
11. Teenagers are old enough to be critical consumers of ads.	1	2	3	4	5

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In any week, how often do you:

	Never	1-2 Times	3-4 Times	5-6 Times	Every Day
1. Watch the news on TV at home?	1	2	3	4	5
2. Read the newspaper?	1	2	3	4	5
3. Read news magazines?	1	2	3	4	5
4. Discuss the news with your child(ren)?	1	2	3	4	5
5. Critically discuss advertisements with your child(ren)?	1	2	3	4	5

Write a brief explanation for each following question.

1. What problems could arise out of showing advertisements in schools?

2. Do you think it is okay to show advertisements in school? Why or why not?

3. Were you involved in making the decision to implement Channel One? ____Yes ____No

4. What factors influenced that decision?

5. Why do you think Channel One has caused such a controversy? Please explain.

6. In your opinion, what is the key issue that educators should be concerned about when considering Channel One?

7. How has your school accommodated the extra 12 minutes to view Channel One news? If there has been any change in daily schedule, how do you feel about it?

8. Highest grade you completed in school?
_____Did not complete High School _____Completed High School _____Some 1-2 years of college, no degree
_____2 yr College or Vocational School Degree _____4 yr college degree _____Graduate School

9. What is your combined household annual income range? ____Less than 15,000 ____15,000-25,000
____25,000-35,000 ____35,000-45,000 ____45,000-55,000 ____55,000-65,000 ____More than 65,000

10. Check your main ethnic origin. ____Asian ____Black ____Hispanic ____Native American ____White

THANK YOU FOR YOUR HELP!

PLEASE RETURN THIS SURVEY TO SCHOOL WITH YOUR CHILD.
IF YOU DESIRE, FEEL FREE TO PLACE IT IN A SEALED ENVELOPE,
LABELED "CHANNEL ONE SURVEY"

Title:

Groupware: A Tool for Interpersonal Computing

Authors:

Nancy Nelson Knupfer
Hilary McLellan

Introduction

Steve Jobs has suggested that the 1980s were the age of personal computing while the 1990s will be the age of interpersonal computing. The advent of interpersonal computing has enormous implications for work and learning. Schrage (1991) reports that "new technologies of collaboration are emerging that will radically transform the way people share their thoughts." Computer networks have provided a foundation for interpersonal computing, but as Schrage mentions, new tools are emerging; the centerpiece is what is called "Groupware." This paper will examine this technology as well as the theoretical framework that will underlie interpersonal, collaborative computing. First, an examination of Groupware.

Groupware

What is "Groupware"? Fraase (1991) defines groupware "as a group of technologies, techniques, and services designed to help people collaborate more effectively, productively, and creatively. Groupware can consist of hardware, software, services, and support." Groupware is based upon the convergence of networking and multimedia technologies. This collaborative computing utilizes networking, communications, concurrent processing, and windowing environments. Hypermedia can also be integrated. Specific media such as voice and video can play major roles in collaborative computing, although the limited ability of computers to recognize or manipulate their content complicates their full integration.

Beyond technical definitions, groupware is about groups of people managing their collective information resources (Fraase, 1991). The collaborative context appears wherever people are working together to add value. Groupware is intended to create a shared workspace that supports dynamic collaboration in a work group over space and time constraints. Supporting team collaboration over time is the central purpose of most groupware. However, groupware can support many activities. Johansen (1988) identifies seventeen functions that groupware can support:

- Face-to-face meeting facilitation
- Group decision support
- Computer-based telephony extensions
- Presentation support

- Project management
- Calendar management
- Group-authoring
- Computer-supported face-to-face meetings
- Screen-sharing
- Computer conferencing
- Text filtering
- Computer-supported audio/video teleconferencing
- Conversational structuring
- Group memory management
- Spontaneous interaction
- Comprehensive workgroup support
- Nonhuman meeting participants (using intelligent agents)

Different groupware systems emphasize different capabilities. Systems that are commercially available tend to emphasize computer networking capabilities. Some groupware packages enhance e-mail with features that help route "compound" documents among coworkers collaborating on a document. At a higher level, groupware is much more than enhanced e-mail --- it's a multiuser database that can be used for group projects. More advanced collaborative groupware packages permit the creation of compound documents made up of several types of media. Group-created documents that are often limited to text and graphics will increasingly take on other data types, such as sound, still video, animation, and movies (Fraase, 1991). Experimental groupware systems under study in research labs in Japan, europe, and the United States exemplify these more sophisticated capabilities. For example, the Xerox PARC Media Space emphasizes videoconferencing, including a computer-based VideoWhiteboard that serves as a drawing tool. This VideoWhiteboard is described as "a high tech version of shadow puppet theater (Brittain, 1991)." It is an electronic screen that can be used for writing notes and drawing diagrams, just like a traditional whiteboard (or blackboard). This VideoWhiteboard can be seen --- and written upon --- by coworkers at different sites simultaneously. For a detailed description of groupware systems, refer to McLellan & Knupfer (In press).

Collaboration

Groupware technology provides a platform to support collaboration and other forms of interpersonal computing. In order to support collaboration via technology, it is essential to understand what constitutes collaboration. Collaboration is not merely communication. Schrage (1991) defines collaboration as "the process of *shared creation*: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own. Collaboration creates a shared meaning about a process, a product, or an event. In this sense, there is nothing routine about it. Something is there that wasn't there before. Collaboration can occur by mail, over the phone lines, and in person. But the true medium of collaboration is other people. Real innovation comes from this social matrix."

According to Schrage, "Quality collaboration --- the kind of efforts that have driven breakthroughs in science, the arts, and technology --- occurs with neither the frequency nor the intensity it should, in part because there are few tools explicitly designed to encourage or support it." Groupware offers the potential to support collaboration, but in designing and implementing groupware, it's essential to understand both the technology and the nature of collaboration. Norman (1991) points out that the same principles that apply to the development of computer systems for individuals are not sufficient for computer systems for groups. It is not these design principles do not apply. Rather, group activity is vastly different from individual activity and has its own needs and requirements. "Technology alone cannot provide the answers when we deal with human activities. The tasks, the culture, the social structure, and the individual human are all essential components of the job, and unless the computational tools fit "seamlessly" within this structure, the results will be failure (Norman, 1991)."

So just what is collaboration? Los Angeles Times reporter Michael Schrage (1991) has written an insightful book, Shared minds: The new technologies of collaboration, that explores this issue in depth: "Collaboration describes a process of value creation that our traditional structures of communication and teamwork can't achieve." The driving spirit behind any collaboration is always dynamic; it should never stagnate. Schrage identifies two types of collaboration: formal and informal collaboration. Formal collaboration is the process we follow in highly-structured settings such as meetings and task forces. This type of collaboration revolves around structures, procedures, and formal processes. Informal collaboration is characterized by less-formal settings and less structured, more casual interactions, for example, crossing paths in hallways, at the coffee machine, over lunch. Informal collaborations are much less structured than a formal collaboration. Good collaborators, regardless of the type of collaboration employed, "accept and respect the fact that other perspectives can add value to their own (Schrage, 1991)." Schrage suggests that we collaborate not only with our co-collaborators but with the symbols people create.

Schrage identifies collaboration goals or outcomes and collaboration constraints. Collaboration may result in (1) Problem solving; (2) Creativity; and/or (3) Discovery. Collaboration constraints include: (1) expertise; (2) time; (3) money; (4) competition; and (5) conventional wisdom and common sense.

According to Schage, there are thirteen design themes that characterize collaboration, including: (1) Competence; (2) A shared, understood goal; (3) Mutual respect, tolerance, and trust; (4) Creation and manipulation of shared spaces; (5) Multiple forms of representation; (6) Playing with the representations; (7) Continuous but not continual communication; (8) Formal and informal environments; (9) Clear lines of responsibility but no restrictive boundaries; (10) Decisions do not have to be made by consensus; (11) Physical presence is not necessary; (12) Selective use of outsiders for complementary insights and information; and (13) Collaboration's end.

Groupware offers the potential to support all of these design themes. Design theme Four --- Creation and manipulation of shared spaces --- is especially relevant to a groupware collaboration context. According to Schrage: "All collaborations rely on a shared space. It may be a blackboard, a napkin, a piano keyboard, a rehearsal room, a prototype, or a model. Independent of whether the collaborators are artists, scientists, professionals, managers, or mechanics, collaborators are inevitably drawn to a shared space to share the ideas and insights that will solve the problem or achieve the task. The shared space becomes a partner in collaboration." Groupware readily offers multiple forms of representation and this capability will increase as the technology advances. Related to this, groupware offers collaborators the capability of playing with the representations. Continuous but not continual communication is made highly convenient in a groupware environment. Some other factors that underlie collaboration include the following: (1) Conflicts are not two-sided; (2) All problems are interdisciplinary; (3) Solutions can be reached by widening the community; (4) Consensus doesn't have to mean unanimous agreement; (5) Voting doesn't work; consensus building does; and (6) Sometimes it's best to just agree rather than trying to agree on why you're agreeing (Schrage, 1991).

The collaborative process can be broken down into two distinct elements: conceptual collaboration, and technical collaboration (Schrage, 1991). Conceptual collaboration is the process of defining the overall goal of the collaboration. This must precede the technical collaboration. An example of conceptual collaboration, according to Schrage, is when a film director and a cinematographer block the action and camera angles before filming begins. Technical collaboration is the actual attempt to solve the problem that was defined in the conceptual collaboration. This is apt to be a process of repeated attempts. A good example of technical collaboration is James Watson and Francis Crick working on the DNA model to establish the structure of DNA (the double helix), based on their conceptual model.

Interpersonal computing is qualitatively different from personal computing. Norman (1991) emphasizes that this qualitative difference should inform the design of interpersonal computing tools. Other analysts speculate about the social impacts of interpersonal computing. For example, Perin (191) explains that electronic social fields --- interpersonal computing --- may threaten managers' assumptions about conventional bureaucratic organizations because they call into question organizational authority, they cross functional divisions, and they create options for the times and places of work. So that while the virtual groups linked by groupware may enhance innovation and productivity in bureaucracies, interpersonal computing may be susceptible to managerial suspicion and negativism. This is an issue that will have to be addressed in the implementation of groupware systems within organizations.

According to Schrage, it is essential for individuals and institutions to make the adjustment to interpersonal, collaborative computing: "As individuals, we each possess special skills and expertise, plus the desire to apply them productively. Yet to a disturbingly large degree, most organizations lack the collaborative infrastructures that enable people to share their talents in ways that satisfy the individual's need for expression and the organization's imperative for results. As a result, people feel increasingly frustrated, and the organizations that employ them moan about declining productivity and shriveled morale. There's no balance." Groupware tools offer the potential to redress the balance so that collaboration can flourish.

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Title:

Restructuring Library Media Centers in Kentucky

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Restructuring Library Media Centers in Kentucky

As a result of the Kentucky Education Reform Act (KERA) of 1990, schools in Kentucky are restructuring through site based management, non-graded primary schools, performance-based student assessment, and instructional uses of technology in order to change the way children are educated within the Commonwealth. Within KERA, technology is viewed as playing an important role in enlarging and enriching the learning experiences of students. Thus, the need has arisen to develop a long range plan for the efficient and equitable use of technology at all levels. In order to facilitate the integration of technology in education, KERA created a state advisory council for educational technology whose purpose it is to design and implement a plan to cover all aspects of educational technology.

The initiation of the Kentucky mandate has forced each school to quickly prepare a five-year technology plan. For many, technology is a new area; one that because of a lack of funds for many years, has been largely neglected in terms of purchases as well as serious utilization studies by individual schools and their library media specialists. Therefore, such a sweeping reform as KERA presents an opportunity to examine not only the implementation of new technological devices but also to track any potential changes in the role of the library media specialists. Preliminary to a long-range examination, a description of the schools' current technological sophistication and the roles of school personnel becomes important. Specifically, determinations are required of the technologies and technology expertise currently within the schools, and the role of the library media specialists in the initial planning and implementation stages.

This paper presents the results obtained in a 1992 survey of library media specialists in southeastern Kentucky. In particular, the paper focus on: a) technological resources currently available in library media centers; and b) the library's media specialists' perception of their role and in the future as a result of the changes brought about by the Kentucky Educational Reform Act.

Survey Results

The results of the survey indicated that the four most widely available, newer technologies are: a) televisions (98%), b) video cassette recorders (97%), c) computers (71%), and d) camcorders (58%). In addition, collections of videotapes and software programs are being housed in library media centers.

The equipment and accompanying instructional materials are most often checked out of the library and utilized by the teachers in the classroom to present information to students. Four technologies existing in less than a third of the library media centers are: a) CD-ROM's (24%), b) automated library systems (16%), c) facsimile machines (11%), and d) videodisc players (2%).

As a result of KERA, schools are beginning to develop their five year technology plans. The five most frequently mentioned technologies desired are: a) computers (44%), b) CD-ROM's (36%), c) networking of computers (35%), d) automated library systems (33%), and e) camcorders (32%).

A relevant finding of the study was that televisions and videocassette recorders were seldom requested in the five year plan. This phenomena can be explained by the fact that the state of Kentucky has had a strong educational television network for several years and, for a period of time, offered matching funds for the purchase of these items.

Two other findings of note were: a) multimedia stations were not reported to exist in any library media centers, and were included in only 13.6% of the technologies plans; and b) only 16% of the library media centers stated that they have automated library systems. However, only 33% included automated library systems in their five-year technology plans.

Perceived Role of the Library Media Specialist

Within the survey, only 42% of the library media specialists felt that the Kentucky Educational Reform Act (KERA) along with the Kentucky Educational Technology System (KETS) will have an impact on their roles as library media specialists. Sixty percent of the schools reported having a technology committee. Of the schools having a technology committee, the survey indicated that 60% of the library media specialists were involved in some capacity with the technology committee. Only, 12% of those involved served as the chair.

Two findings were significant. Only, two-thirds of the library media specialists felt that technology will affect their collection development. In the teaching of search strategies, 28% of the respondents stated they will teach only the automated catalog. In contrast, sixty-two percent stated that they will teach both the traditional card catalog and automated catalog search strategies.

The results of further in depth interviews with library media specialists suggested that they feel dramatically unprepared to use technology themselves or to help the classroom teacher integrate the technology into the curriculum. Apparently, the library media specialists are overwhelmed with the variety of technologies available and appear to be confused in determining the direction needed for the library media centers. Several library media specialists indicated that they prefer to remain in the traditional role of the librarian where they only care for the books and students who come to the library. Finally, the emerging role of the library media specialists as an information broker is retrieved from a student workstation not necessarily in the library media center.

Summary

This survey provides a first step in tracking the technological changes as a result of KERA and KETS. The results of the survey indicated that few library media specialists are aware of the newer technologies and their role in the library media centers. Furthermore, library media specialists continue to view the library as a storage and lending area of books rather than a technologically rich information or production area for teachers and students.

Title:

Interactivity and Multimedia Instruction: Crucial Attributes for Design and Instruction

Author:

James J. La Follette

INTERACTIVITY AND MULTIMEDIA INSTRUCTION: CRUCIAL ATTRIBUTES FOR DESIGN AND UTILIZATION.

Increasing interest in currently available multimedia technologies capable of providing interactive learning experiences has resulted in widespread enthusiasm. This has been particularly true of technologies incorporating the laser videodisc interfaced with a computer and other optical disc technologies, including configurations commonly identified as multimedia systems. Electronic multimedia does hold the promise of providing easy access to information that has untold richness of multiple images and sounds (Ambron, 1988). Multimedia certainly provides the ability to illustrate ideas with pictorial, audio, text, or any combination of stimuli.

On the other hand, we continue to read claims that research suggests no learning benefits can be gained by employing a specific medium to deliver instruction, regardless of the learning task, learner traits, symbolic elements, curriculum content, or setting. (Clark, 1983; Clark & Salomon, 1987; Clark & Sugrue, 1988).

When the psychological effects of a presentational medium are considered in terms of the contribution they make to specific educational outcomes, the concern is with the effects of specific media characteristics on specific individuals and with the functions they accomplish relative to given instructional tasks (Salomon, 1974). Recently the assumption that there is a one-to-one correspondence between coding elements and afforded activities, on the one hand, and specific modes of mental representation on the other has been questioned (Clark & Salomon, 1987). Still, a useful classification distinguishes *structural* media attributes from *functional* media attributes to facilitate differentiating media on the basis of their function for influencing and activating different kinds of learning processes (Heidt, 1977,1978).

The goal of this paper is to explore attributes of multimedia learning resources: the physical resources; the learners; and instructional design factors which appear to be crucial in determining interactive capability and potential for instruction.

Three significant dimensions will be examined, beginning with a **Sensory Dimension**, which includes structural media attributes and also incorporates an imposed communication variable, message treatment. Next a **Processing Dimension**, which relates more closely to the functional attributes of media. This dimension will be approached primarily from the perspective of what the learner brings to the media. Finally, a **Control Dimension** is introduced, represented by a continuum from total control exercised by the program designer to the ability of the learner to manage the learning situation completely free of program control.

In terms of the internal operations of the learner, we need to consider how the structural attributes of a medium used as a technology for instruction can be utilized as functional attributes which facilitate effective mental processing. Based on the assumption that the factors which underlie the use of media for instruction are the symbol system, the message, the learner, and the educational task (Salomon, 1974), our Sensory Dimension relates to both the symbol system and the message. The Processing Dimension essentially treats the learner's interaction with the symbol system, the message, and the task. The Control Dimension deals with selected aspects of the task, although overlap with the message is obvious.

Each of the dimensions represents a continuum. A cube diagram (Figure 1) presents possible interrelationships among the various dimensions.

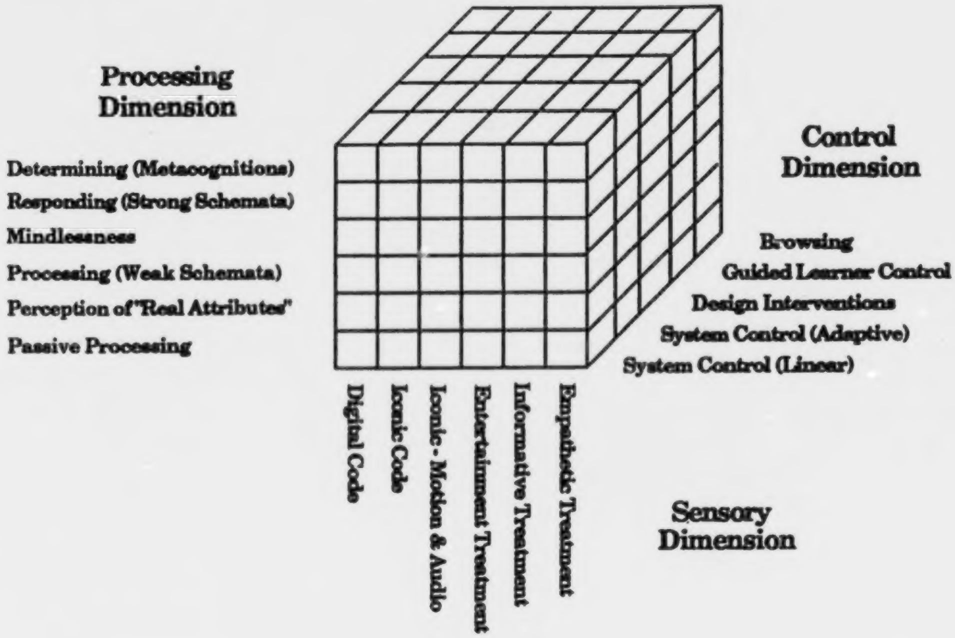
Processing Dimension
Determining (Metacognitions)
Responding (Strong Schemata)
Mindlessness
Processing (Weak Schemata)
Perception of "Real Attributes"
Passive Processing
Control Dimension
Browsing
Guided Learner Control
Design Interventions
System Control (Adaptive)
System Control (Linear)
Digital Code
Iconic Code
Iconic - Motion & Audio
Entertainment Treatment
Informative Treatment
Empathetic Treatment
Sensory Dimension

Figure 1. Crucial Attributes of Interactive Instruction.

THE SENSORY DIMENSION

The Sensory Dimension suggests the possibility that as each additional structural media attribute or communication treatment variable is utilized, the potential for perceptual saliency is increased. Salomon's conclusions that it is the symbol system rather than the technology of transmission which is crucial for instruction, and that symbol systems are the primary, most essential attributes of media (1974, 1979), provided a point of departure from treating media as global, holistic entities. However, other aspects of symbol system theory may be less secure. In particular the assumption "that cognitive representations and processing are carried out in *various* symbolic modes that are *influenced* by the symbol systems employed by media, that some of these cognitions are *unique* counterparts of communicational symbol systems, and thus can be cultivated by symbol systems" (Clark & Salomon, 1987, p. 469), has been challenged.

For the purpose of examining the attributes of instructional systems, the concept of symbol systems is useful. Based on Goodman (1968) an important means of analysis is notationality. A notational system (e.g. languages; musical notation) consists of a set of separate, discontinuous characters correlated with a field of reference which is further segregated so that any character in the system isolates the object or objects it stands for. In contrast, nonnotational systems (e. g. pictures) are continuous and unsegregated with no set of isolated characters (Gardner, Howard & Perkins, 1974).

A related aspect of the Sensory Dimension has to do with perceptions of reality in the light of potentially vicarious mediated experiences. Several researchers have studied the perceptions of reality of television viewers. Dorr (1983) suggests various criteria which people use to judge reality: reality can represent a simulated experience in which characters, actions, messages, or themes in some way conform to real life; something is judged real if it is deemed possible; and a presentation is only judged real if it is considered probable or representative of reality. Considered from the viewpoint of the phenomenological school of philosophy, perceived reality can evolve through "bracketing" or the willing, but temporary, suspension of disbelief. The physical world isn't eliminated, but people simply disengage from it by bracketing it out and accepting the content and context of the media as real (Jonassen, 1984).

A classification placing symbolic modalities into categories of digital signs and iconic signs (Levie, 1978) will be familiar to most readers. As noted by Knowlton (1966), digital signs are essentially arbitrary and do not have natural referents, while iconic signs tend to bear a concrete resemblance to something for which they stand.

Digital Codes

Digital signs should be considered in terms of sensory modality. Common examples of digital signs in the visual modality are printed words, numbers, and semaphore code. Spoken words represent by far the most common auditory form of digital signs, although Morse code and alarms of various types constitute other examples (Levie, 1978).

Of much interest to our search for crucial interconnections among attributes of interactive instruction is the concept that human information processing involves the verbal symbolic system in interaction with an imaginal symbolic system (Paivio, 1971). "Thus, language can activate representations of nonverbal objects and events, which may be experienced in the form of mental imagery. Conversely, nonverbal objects and events, or mental images, can be described" (Paivio, 1983, p. 206).

Iconic Codes

The human imaginal system is specialized for processing spatial, simultaneous information of a relatively concrete nature. The system is also considered to perform independent operations, called "mental imagery", or "visual thinking". Iconic signs in the visual modality include pictures, statues, and gestures. Iconic signs in the auditory modality include sound effects and music (Levie, 1978). Although these symbol systems are low in notationality, they should not be considered easier nor more difficult to comprehend or learn than other systems (Gardner, et al, 1974; Clark & Salomon, 1987).

Iconic - Motion & Audio

Formal attributes of audiovisual presentations include action, pace, visual techniques, and verbal and nonverbal auditory events. Such attributes result from production and editing techniques and are defined independently of content.(Huston & Wright, 1983).

Several studies have analyzed the relationship between formal attributes and visual attention. Although many of the studies involved children, the results are interesting in terms of their potential relevance for learners of all ages. Production features which tend to maintain and elicit the attention of young children include motion, audio change, and sound effects (Anderson & Lorch, 1983).

Formal features of television which possess the quality of perceptual salience were identified by Huston and Wright (1983). Attributes identified as salient included physical activity of characters, rapid pace, variability of scenes, visual special effects, loud music, sound effects and peculiar or non-human voices. Features identified as lacking perceptual salience include human speech, physical inactivity, and background music. Moderate action and zooms were classified as having moderate perceptual salience.

The effect of formal attributes is influenced by the learner's greater familiarity with a medium's attributes, and the learner's cognitive skills, linguistic and imaginal competence, and cultural knowledge. Huston and Wright (1983) discovered that perceptually salient attributes have much less influence on the attention and comprehension of older children and adults, compared with younger children.

Treatment: Entertainment; Informative; Empathetic

Cognitive social psychology suggests that people actively affect their environment through their personal and socially shared perceptions and they experience the consequences of their activity in a reciprocal, rather than linear fashion. "Thus, from the social learning perspective, psychological functioning involves a continuous reciprocal interaction between behavioral, cognitive, and environmental influences" (Bandura, 1978, p. 345). This reciprocal paradigm seems to imply a limited role for perceptually salient media attributes, however, communicational treatment provides one possible area of influence.

The concept of treatment relates to the manner in which the content, code, and structure of an instructional system is organized and presented. One classification of treatment forms identifies: "expository"; "dramatic"; and "personal involvement" (Kemp & Smellie, 1989).

Treatment can also be considered an aspect of communicational intent. It is possible to distinguish between different kinds of communicational events according to their perceived intent: intent to entertain; intent to convey (inform or share); and intent to change (Salomon, 1981).

Familiarity with the formal attributes of popular media could be a possible recommendation for using an entertainment treatment for instruction. Research results suggest otherwise. For example, Ksobiech (1976) found that university undergraduates who were told that a televised lesson would be entertaining performed poorly on a subsequent exam, compared to a group who were told they would take a test following the presentation, and another group which was told they were to evaluate the lesson.

Messages with treatments which convey the perception that the communicator is definitely attempting to influence or persuade the receiver will tend to be seen to limit one's freedom of thought or choice, and consequently are likely to be countereffective. Events which convey the perception that the only intent is to convey, or share information are considered more effective (Salomon, 1981). However, potential problems with excessive use of sterile information treatments could exist. Informative and interesting would seem to be a minimal guideline, calling upon the creative talents of instructional designers. A possible approach involves dramatic treatments which convey the communication intent of conveying information.

Some of the communicational intent of designers, even when the principal goal is to inform, includes persuading (motivating) the learner to accept the message as well as processing the information. The personal involvement treatment could counteract negative effects, but is difficult to carry out. An area of possible exploration would be to attempt what might be called an empathetic treatment. The goal would be to demonstrate the personal value of the communication to the receiver, in order that the attribution of intent would not be perceived as promoting the vested interests of the communicator.

THE PROCESSING DIMENSION

A popular assumption suggests that external forces strongly influence an individuals knowledge acquisition, attitudes, behaviors, and cognitive skill mastery. Learners are considered to be reactively controlled by media and instructional displays and the learner is perceived as an active responder to the medium's demands. The medium can be said to differentially activate cognitive or emotional responses from individuals with particular cognitive abilities or tendencies. The nature of the responses depends jointly on the attributes of the medium and on those of the individual (Salomon, 1983; Anderson & Lorch, 1983).

An alternative view contends that attention to instructional displays is actively under the *control* of the learner. The learner is perceived not only as a responder, but also as a potential determiner of the experience. Learners do not necessarily respond to the "real" attributes of the medium, but apply their own often culturally shared perceptions and attributions (the partial results of prior exposure to the media), which in turn affect the kind of experiences the learner realizes (Salomon, 1983; Anderson & Lorch, 1983).

There is reason to believe that the two perspectives are complementary. People are affected by their environments, but they actively influence their environments through their personal and socially shared perceptions. This reciprocal viewpoint implies that efforts to account for the impact of multimedia instructional systems should consider what the learner brings to the setting at least as much as what the system presents to the learner (Anderson & Lorch, 1983).

The initial stages on our continuum of processing: Perception of "Real Attributes" and Processing (Weak Schemata) basically represent a traditional S-O-R model of learning where the "O" represents internal processing which links the stimulus and the response. Here attention and reaction to the environment and its displays is dominant. The stages: Responding (Strong Schemata) and Determining (Metacognitions) represent a cognitive processing paradigm where previously developed schemata incorporating previous skill, information, and knowledge guide the learner's perception and largely determine present and future interactions. The stages: Passive Processing and Mindlessness represent aspects of each paradigm where superficial, automatic, or an absence of processing takes place.

It is suggested that both stages of the processing continuum operate when a learner encounters instructional displays and that they usually act in concert (Salomon, 1983). Top-down processing is guided by anticipatory schemata typical of search behavior , while bottom-up processing is guided mainly by the saliency of stimulus properties. "Apparently, the more one knows about a topic, and the better a new unit of material fits into a preexisting frame, conception, or schema, the more top-down processes dominate (assimilation); when the material is relatively novel (but not too novel) and being handled by impoverished schemata, bottom-up processes dominate (accommodation)" (Salomon, 1983, pp. 185-186)

Passive Processing

Instructional media and instructional systems have often been classified as "message or stimulus" oriented or as "response" oriented. Stimulus oriented media are characterized by their emphasis on input to students, the message and its' design, with very little concern for the explicit nature of the response(s) students are to make to a particular message or portions of it (Gropper, 1976). While clearly taking a response oriented approach, Gropper labeled media which do not themselves impose the conditions thought to be necessary for learning, such as use of feedback, as passive. Such media as films, television, radio, slides, slide-tape, audiotape, and print were identified as passive carriers. Active carriers (e.g. programmed instruction, CAI) deliberately and systematically dictate particular conditions for learning. Such classifications may have contributed to common perceptions that motion pictures, television and other presentation media facilitate only passive processing.

Termination of attention, the equivalent of passive processing, would be expected to occur if presented material were sufficiently unfamiliar or difficult and the learner was unable to activate and apply a comprehension schema (Anderson & Lorch, 1983).

Perception of "Real Attributes"

Processing of popular media has been considered, if not passive, at least reactive as opposed to active. Extrapolation of this approach to instruction suggests that an audiovisual medium elicits and maintains attention via salient formal features, both visual and auditory. The direction of influence is from the medium to the learner. The influence of learner intentions, plans, strategies, and previous experience are minimal. Relatively automatic comprehension and retention processes are assumed to occur, once attention has been gained (Anderson & Lorch, 1983).

Salomon (1981) suggests that media can induce "naive changes" to schemata when the schemata are weak, poorly integrated, isolated, not salient, not important, or not readily available. Perception of the content of an instructional presentation may occur when the salience of the formal features elicits and maintains attention to the system. This has been equated with a type of "exploration" as the learner responds to immediate, salient, discrete aspects of the stimulus setting. Exploration is most common when the learner is unfamiliar with the situation being presented (Huston & Wright, 1983).

Processing (Weak Schemata)

Exploration may be said to move gradually to perceptual search when the learner is guided by internally generated goals, rather than by external sensory events. At this stage some of the features that attract attention may be perceptually salient, but learners are attracted to the display features because of their informativeness or relevance to personal goals, rather than on their perceptual characteristics (Huston & Wright, 1983).

Even though the schemata may be well integrated, salient, and important in the learner's repertoire, media can influence changes to schemata which are insufficiently developed to handle certain novel events. Such actions have been characterized as information seeking processes (Salomon, 1981).

Mindlessness

Mindlessness, or stereotypical reenactment represents the absence of active conscious processing. It has been shown that people engage in mindless behavior when they encounter events that appear to them as highly familiar, overlearned, and repetitious. Individuals engaged in mindless activity may give the appearance of mindful action, but new information is not actually processed. In particular, when the structure of a communication is congruent with a receiver's past experience, it may result in behavior which is "mindless" of relevant details. (Langer, Blank & Chanowitz, 1978). Thus what learners are capable of doing is not necessarily what they actually do. The mindlessness phenomena would seem to account for the performance of learners who appear quite capable, but continually fail to master curriculum goals, despite repeating the same material several times.

Responding (Strong Schemata)

It is at this stage that prior knowledge and skills, which are stored in the schemata and are available for processing come into play. Thus, the essence of the *reciprocal paradigm* which "postulates that personal dispositions, attributions of intent and meaning, communicational behaviors, and educational outcomes are reciprocally related to each other. We are influenced by others' messages, but it is our (often a priori) interpretation of the messages that influence the way we are influenced" (Salomon, 1981, p. 211).

Determining (Metacognitions)

Metacognitions tell us when, under what conditions, and for what purposes we are to apply schemata. Learners influence the way they interact within an instructional system, not just by responding through the skills and knowledge the system evokes in them, but also through metacognitions that they apply to it. Learners may also develop new internal strategies about how to learn as they interact with an instructional system. At this stage the learner is *determining* not only *what* material will be processed, but also *how* it will be processed. We could expect learners to apply alternative schemata, if available, depending upon their intentions, goals, and the perceived demands of the setting (Salomon, 1981; 1983).

THE CONTROL DIMENSION

A crucial aspect of interactive instruction which relates to the learner's processing of the media within a complex instructional system is the manner in which the system permits control during learning. Under learner control, adaptive instructional decisions are made by the student, in contrast to system control where instructional decisions (adaptive or linear) are made for the student. Design decisions along this dimension, in interplay with the learner and the medium would seem to determine the true nature and quality of the interaction involved.

If we accept the principles of interaction implied in the "Reciprocal Paragigm" and current claims of cognitive learning theory: constructivistic (Bednar, Cunningham, Duffy, & Perry, 1991; Duffy & Jonassen, 1991) and generative (Wittrock, 1977;1979), it seems evident that even in situations in which the presentations are selected, sequenced , and paced for the student, a great deal of learner control will still be exercised by the student. Concluding that all instruction involves some learner control, Merrill (1984) suggested that "the challenge is not whether or not learner-control should be made available, but rather how to maximize the student's ability to use the learner control available (1984, p. 239). There is little positive evidence favoring total, unaided learner control. Research indicates that learner control with some form of coaching has been consistently superior to unassisted learner control (Hannafin, 1985). Thus, "The capabilities of the *learners* to use control options effectively is a more salient consideration than the capability of the *technology* to permit control" (Hannafin, 1985, p. 243).

Perhaps predictably, the research has begun to suggest that "learner control is not a unitary construct, but rather a collection of strategies that function in different ways depending on what is being controlled by whom" (Ross & Morrison, 1989, p. 28). Thus, a continuum of instructional control is implied (Figure 2), and indeed the research continues to feature attempts to identify specific situations in which learner control or program control, or some combination along a continuum, is most effective.

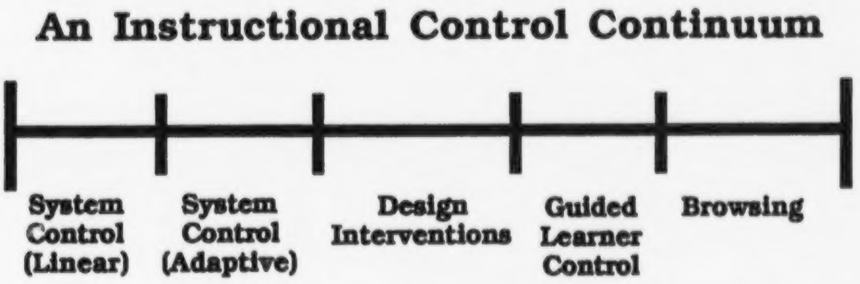

Figure 2. Representation of a Continuum of Instructional Control.

System Control (Linear)

System control of instruction is characterized as external, and is identified with instruction in which all learners follow a predetermined route established by the designer without using individual judgement as to the appropriateness of the path (Hannafin, 1984). Externally controlled CAI has proven effective in drill and practice tasks involving lower order intellectual skills (Hannafin, 1984), however the evidence suggests that contextual and substantive information and higher order skills may be best taught using learner control (Kulik, Bangert, & Williams, 1983).

System Control (Adaptive)

Although some CAI and Interactive Video instruction has been designed along the lines of a linear programming model, system control does not necessarily connote a linear approach. Tutorial CAI is more the ideal. An example of rigid system control is a version of tutorial CAI, based on a performance or response driven adaptive instructional model. The learner is given practice problems as part of the presentation and the next display is determined from the response. Any adaptation is the same for all learners, but if some branching is used, a learner would see one display if the response to the previous frame was correct, and a different one if it was incorrect. It has been suggested that provided the content is fixed, such a system is similar to a lecture, and even more limited than a textbook in providing the opportunity for the learner to override the system . Even systems which incorporate an idiosyncratic adaptive model for each student have been programmed in such a way that learner control is very limited (Merrill, 1984).

Design Interventions

Several design enhancements within a system control approach are supported by research evidence. Learning has been shown to be most effective when criterion questions are embedded throughout the lesson. As well, questioning and response feedback procedures have been shown to increase comprehension and attention to instruction using interactive video (Hannafin, 1985). Providing examples in a variety of contexts has been identified as a promising strategy which facilitates independent adaptive decision making by learners (Ross, Morrison & O'Dell, 1989).

Idiosyncratic adaptive instruction, and instruction utilizing the above design enhancements may each be seen as an attempt to assist the individual to most successfully achieve desired program goals and objectives. Thus both may be more effective in situations where there is clear agreement on the desirability of all students mastering relatively specific instructional outcomes.

Guided Learner Control

Situations in which considerable learner control is afforded, but with advice given to the learner (internal program guidance) is a promising approach. Research evidence verifies the desirability of including some form of "coaching" to assist learners in making informed decisions (Hannafin, 1984; Ross, 1984; Tennyson and Buttrey, 1980). Successful procedures have been developed in research settings which offer guidance upon which individual student's decisions can be based. The program can advise the learner as to the number and types of practice items or examples recommended, current mastery status, and other performance features. The advisement is based upon the individuals past, current, or cumulative performance during a given lesson. The learner maintains control by being able to accept or reject the offered advice (Hannafin, 1984; Hannafin, 1985).

Emerging learning theory suggests that even in settings where instructional displays are selected for, sequenced for, and paced for the student, a great deal of learner control will still be exercised by the student. While engaging in a lesson, learners acquire internal strategies about how to learn, in addition to subject matter. This *metacognition* refers to the "how to study" model which the student uses to guide interaction with the instructional system (Merrill, 1984). According to Merrill "the challenge is not whether or not learner-control should be made available, but rather how to maximize the student's ability to use the learner-control available" (1984, p.239).

A major thrust of research by Merrill and associates with adaptive CAI featuring internal learner control involves attempting to guide the learner by providing carefully defined strategy options for controlling display presentation. They suggest that students can be taught more appropriate processing procedures and encouraged to use the strategies (metacognitions) where appropriate. A promising early result was the conclusion regarding the hypothesis: "Students who are provided directions for conscious cognitive processing of the information presented will perform better than will students who are left to their own internal processing strategies". Students who received directions about how to process the information scored higher on the posttest than students who didn't receive the directions.

Browsing

Browsing is the label used to subsume the variety of things which could happen at the end of the continuum where the learner is generally considered to be in control, or at least interacting directly with the system. One attempt to define browsing describes it as the intellectual process of acquiring individualistic knowledge (Jonassen, 1989). A total learner control orientation would imply allowing learners to make decisions about what they want to learn by selecting options which are presented at different points in the lesson (Ross, 1984). The least sophisticated use of multimedia as an *information reference tool* might be termed *nibbling* , with the user aimlessly probing through a dense information base.

However, it is necessary to consider other approaches to learning, as well as other approaches to utilizing the information potential of multimedia systems.

Recent controversy over the instructional design model commonly employed within the field of instructional technology has implications for interactive multimedia. Claiming that instructional technology had accommodated cognitive psychology in its theory, but very little in its practice, Jonassen (1990) urged the field to move toward a *constructivist* view of instructional design. He pointed out that cognitive information processing is not fundamentally different from behaviorism, since both rely upon an objectivistic conception of knowledge.

A definition of constructivism provided by Jonassen (1990) will be useful to a further discussion of the issue:

> Constructivism is the belief that knowledge is personally constructed from internal representations by individuals using their experiences as a foundation. Knowledge is based upon individual constructions that are not tied to any external reality, but rather to the knower's interactions with the external world. Reality is to a degree whatever the knower conceives it to be (p. 32).

An extreme position on constructivism advocates that it become the sole basis for instructional design. It is claimed that since the goal of instruction for both behaviorist applications and cognitive information processing is to communicate or transfer knowledge to learners in the most efficient, effective manner possible, it is not tenable to add constructivist theory to the "smorgasbord" of behaviorism and cognitive information processing (Bednar, Cunningham, Duffy & Perry, 1991).

Reigeluth (1991) responded to Bednar, *et al*, as well as other writers who suggest such an extreme view of constructivism. He pointed out that constructivism does have much of value to educators, but that other perspectives do as well. Some of the major tenets of constructivism have long been espoused by instructional technology. For example instructional designers "have for some time advocated 'situating' learning experiences in authentic activities" (1991, p. 34). The need to couch instruction in a context that is meaningful to learners has been identified as perhaps the most significant aspect of constructivistic design (Jonassen, 1991). Certainly most instructional designers and teachers would not disagree, but they might also report much frustration from attempts at trying to situate their instruction in appropriate contexts.

Recent interest in multimedia has been accompanied by claims and suggestions of potential user empowerment. We agree with Merrill (1991), who advocated that moderate constructivism has much that should be considered by instructional designers, and pointed out that much of his own work in developing ID$_2$ is an attempt to provide tools that enable the development of the type of learning environments that they describe. Merrill argued, however, that the assumptions about the learning process made by extreme constructivistic authors as Bednar, *et al* (1991) are unnecessarily restrictive and may actually prevent the more effective instruction they advocate.

Much of the enthusiasm for multimedia is for purposes other than intentionally created learning environments. It is multimedia systems which are designed to be used as information reference tools which actually represent the focus of much of the discussion relating to learner empowerment and freedom.

Learners using hypermedia are said to be freed from the linear tradition of printed text. "They are encouraged to browse a hyperdocument, move easily among vast quantities of information according to plan or serendipity, follow relationships pre-coordinated by the author or create their own paths through the information" (Marchionini, 1988, p. 8).

Freedom and empowerment mean that learners, particularly where specific instructional outcomes are an issue, require new strategies and tools for making the best use of their time and effort. The challenge to designers is to devise ways to help learners manage this freedom of learning (Marchionini, 1988). Thus, the importance of careful design and development is no less critical in the design of instructional hypermedia environments than for other learning formats. "In order to successfully use a hypermedia application, learners must be provided with appropriate and clear navigational and conceptual tools in order to explore even the best-designed systems" (Morariu, 1988, p. 19).

Given the power of emerging technologies, would it not be possible for a multimedia system to provide in effect a continuum of experiences? Could not the potential resources for structured and unstructured experiences alike reside within something called an intelligent hypermedia knowledge system for learning? And could not such a system accommodate objective instruction in well-defined domains as well as provide an open environment for active learning which enables learners to make their own decisions

Most of this discussion has dealt with inquiry in various areas of education and instructional technology in the belief that it has the promise of being translated into practical guidelines for multimedia development. Inquiry specific to multimedia is beginning to appear in the literature, much of which suggests careful and systematic research on specific aspects of hypermedia. For example, Story and Harvey (1991) reviewed existing research on hypermedia browsers (structural iconic browsers, or maps intended to facilitate navigation through a hypermedia system). However, much of the literature deals with development, which as Park (1991) suggests, essentially involves hypertext and not true hypermedia or multimedia at all.

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Title:

Empowering Learners Through Metacognitive Thinking, Instruction, and Design

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Ming-Fen Li

EMPOWERING LEARNERS THROUGH METACOGNITIVE THINKING, INSTRUCTION AND DESIGN

by Ming-Fen Li

BACKGROUND

Since the enthusiasm for school restructuring swept the U.S., the role of learners has received increasing attention. Learners are no longer perceived as passive knowledge-consumers. What interests educators now is how to create a learning-centered environment to enhance learning achievement. With this increased awareness of the importance of learners, numerous proposals have been brought forward to restructure public education through technology, to empower teachers to redesign curricula and reorganize learning activities, to involve parents in extending learning beyond school, and to rearrange learning resources to narrow the gap between societal needs and school education. While much effort is expended to make learners the decision-makers of their own learning through the above approaches, I believe that the success of a learning-centered environment lies not merely in restructuring the environment external to the learners, but also in enabling learners to cultivate reflection upon their own learning.

Cognitive psychologists have identified the way one exercises mental processes as the most significant determinant in successful learning. Flavell (1978) coined the phrase "metacognition" for the way learners controlled and directed their own mental processes. Since then, metacognition has received more and more attention and has been applied in these contexts of learning. It is important to know how to present metacognition in various contexts of learning, instruction and design in order to enhance learners' mental capabilities and potential. Teaching students how to exercise their metacognition means kindling their intrinsic motivation and enabling them to assume the responsibility of learning, instead of overrelying on the teacher's external motivation.

STATEMENT OF THE PROBLEM

After Flavell coined the term metacognition in the early 1970s, there has been an increasing interest in exploring the essence of the concept and in constructing instructional models for promoting metacognitive learning. A great deal of research (Brown, Bransford, Ferrara, & Campione, 1983; Paris & Lindauer, 1982; Wellman, 1983; Paris, Wasik, & Vander Westhuizen, 1988; Pressley, Borkowski, & O'Sullivan, 1985) supports the importance of metacognition in cognitive development and academic learning, demonstrating that learners who are metacognitively active tend to perform better on cognitive tasks than those who are not, and that metacognition distinguishes an expert problem solver from a novice. Up to the present, research in metacognition covers several primary areas, such as the enhancement of disabled student learning, reading comprehension and monitoring, and problem solving. With successful application in these areas, the role of metacognition is becoming prominent. It has received more and more attention in both educational and training contexts, like the other higher-level thinking skills, such as critical thinking, problem-solving and inquiry (Leshin, Pollock &

Reigeluth, 1992).

Nevertheless, despite the fruitful findings in the literature, scholars do not agree on the definition of metacognition, defining it in various ways in the course of the past decades. This has caused a lot of confusion and remains a thorny problem to be solved. While the evolution of the diverse definitions of metacognition can be attributed to the new discoveries in learning psychology, and scholars' different use of it (Jones & Idols, 1990), there is a need to borrow new perspectives in order to come to a better and more comprehensive definition.

Current models of metacognitive instruction are predominantly developed for reading comprehension and science education. As learning tasks become more and more specialized in education and training, these models are inadequate to accommodate the wide varieties of content. Many instructional models on metacognition have simplified metacognitive instruction into a set of procedures, excluding many humanistic, social and cultural factors. Despite the various models of metacognitive instruction, there is a poverty of comprehensive information on how practitioners can design their own lessons by incorporating these models, since they are instructional models rather than instructional design models.

All of this calls for a close examination of the nature of metacognition and the way people teach it. Rather than teaching metacognition as a group of strategic skills encompassing the whole story of a learning task, I propose that the role of metacognition should be repositioned in a larger context of learning. It is imperative to provide guidance for practitioners on how to apply metacognitive instruction to a wider range of content, and design metacognitive instruction without sacrificing the knowledge of how people develop their metacognition, or neglecting the new ideologies and assumptions which underlie a specific learning task or content.

PURPOSE OF THE RESEARCH

The purpose of the research is to provide a set of perspectives for empowering learners through metacognitive thinking, instruction and design. These perspectives are based on a new conceptualization of metacognition and an integration of learning and instruction. Previous conceptions about metacognition are problematic since most of them place the emphasis on monitoring and learning strategies, neglecting the true nature of metacognition and the process by which learners acquire metacognitive skills. Current instructional theories have been overemphasizing the optimization of instruction, separating to a large extent design from instruction (Winn, 1989; Streible, 1991), making the enterprise of instructional design difficult to apply to many contexts. In addition, because of its focus on strategies acquisition, the existing design of metacognitive instruction is procedural-oriented, isolating metacognitive learning from creativity and other critical thinking skills. Therefore, this research will ground the design of metacognitive instruction more solidly on the nature of metacognitive learning.

CONCEPTUAL FRAMEWORK

The philosophical conceptual framework of the research will be the foundation of this research. This conceptual framework primarily comprises an investigation of the nature of human thinking and metacognition, the power of mental ability, the oneness of knowing and doing, and reflection upon the buried SELF in this highly technological and scientific world.

The lost horizon

Human beings have always been driven to innovate technology in order to improve life.

While enjoying the fruits of technology, and relying more and more on modern technology, they gradually neglect the inner self. The journey of metacognitive learning, instruction and design is to find that buried self and restore our full mental ability.

Power of mental thinking

A learning environment is usually easy to change if resources are available and technology is ready for it. However, the rearrangement of the learning environment does not always result in the reconstruction of one's mindset. When technology fails, we should look for the cause not in technology itself but rather in defects of human mental perspectives. Nevertheless, people still tend to be convinced by the power of technology, rather than that of their mental thinking. While educators align themselves with various endeavors in school reform, they should turn to the learners' internal world to explore its potential in order to enhance achievement.

Oneness of knowing and action

The power of inner thoughts lies in its determinant force of driving actions, especially actions for decision-making about learning and life. Back in the sixteenth century, a Chinese neo-Confucianist, Wang Yang-Ming (1472-1529), devoted most of his life to figuring out the inter-relationship between knowing and action. He first examined two premises: knowing is difficult and action is easy; action is difficult and knowing is easy. Then he proposed a theory that knowing is action, i.e. the oneness of knowing and action. In a similar manner, several scholars have recently called for situated or situational learning, claiming that learning is contingent upon doing, and only when learning is indexed in context can learners truly benefit from the knowledge (Brown, Collins, & Duguid, 1989). These scholars seemingly emphasize that learning comes with or after doing, and that knowledge can not be separated from the context to which it will be applied. Their argument for integrating learning and doing also exemplifies Wang's belief, and lays out the approach that makes possible the fusion of knowing and action.

MEDIATION OF EMPOWERMENT - METACOGNITION

What is Metacognition?

As stated earlier, Flavell (1978) is the pioneer of research on metacognition. He places emphasis of metamemory on the learner's knowledge about variables related to the person, task, and strategies. Scarr and Zanden (1984) define metacognition as awareness and understanding of one's mental states, abilities, memory, and processes of behavioral regulation. Some researchers simplify the term as mere knowledge about one's thought process or thinking about thinking (Glover, Ronning, & Brunning 1990), while others break it up into several subskills. For example, Brown (1978) emphasize aspects of executive cognition such as planning, monitoring, and revising one's thinking; Gall, Gall, Jacobsen and Bullock (1990) define the components of metacognitive skills as knowing the learning process, selecting appropriate learning strategies and monitoring how one's learning strategy is working. Beyer (1987) elaborates the definition of metacognition by incorporating the ability of planning how to carry out the task and carrying it out, monitoring one's process, adjusting one's actions to the plan, and revising both plan and actions in the process. Paris and Winograd (1990) characterize metacognition as knowledge about cognitive states and abilities that can be shared among individuals. According to them, metacognitive skills include both cognitive and affective characteristics of thinking.

Function of metacognition

The many definitions of metacognition, however different from one another, can yet be seen as a combination of learning and monitoring strategies (Bonner, 1988). Most researchers have now blended those twin approaches into a definition that emphasizes (a) knowledge about cognitive states and processes and (b) control of executive aspects of metacognition (Borkowski, 1985; Brown et al., 1983; Wellman, 1985; cited from Paris & Winograd, 1990). However, I believe that the core of the concept is the dynamic thinking process--critical and conscious action, which is actually Wang's argument that knowing is doing from the viewpoint of learners. Instead of the proceduralizing of the components of metacognition applied by earlier researchers, I contend that looking at the core of metacognition, focusing on its power, and contemplating how one becomes metacognitive are what educators need to do. The dynamic reflective thinking process exerts influence beyond controlling and directing one's learning strategies. It is a key to one's inner "whole", a compass on the sea. Therefore, instead of teaching students what to learn, teachers should have a full understanding of the complex nature of metacognition in order to guide students how to learn and think.

Metacognitive thinking functions to liberate learners from the rigid and proceduralized instructional environment imposed by the instructors, administrators or the whole school system. It emancipates one's potential, making possible independent, life-long learning. When school reformers claim to create a learning-centered environment in schools and to give more freedom to learners, they should contemplate how to enable learners to use such freedom. Therefore, unlike most people who concentrate on the components of metacognition, I would like to emphasize its process in this paper, recognizing that metacognition is a developmental process, and everyone's metacognitive process is different.

NEW PERSPECTIVES OF METACOGNITIVE THINKING

Reconceptualization of metacognition

Traditionally, metacognition has been treated as the combination of learning strategies and monitoring strategies, or the evaluation and revision of them. While learning strategies, the newly learned in particular, tend to be external to the learners, monitoring, evaluation and revision are learners' exercise of internal mental process on these external, or to-be-acquired, strategies. However, metacognition cannot be studied in isolation from critical thinking or creativity, nor should it be studied separate from drifting thoughts. As Borkowski, Carr, Rellinger and Pressley (1990) contend, metacognition tends to last for short period of time. How it is interfered with by drifting thoughts and how it interacts with other mental activities should be clarified in order to provide practitioners with more illuminative guidance.

Nature of thoughts: While characterizing thinking by cognition and metacognition, Beyer (1987) does not tell us precisely how people really think. Scarr and Zanden (1984) affirm that people think in two distinct ways--directed thinking and nondirected thinking. According to them, directed thinking is a deliberate, purposeful, systematic and logical attempt to reach a specific goal, whereas nondirected thinking consists of a free flow of thoughts through the mind, with no particular goal or plan, and depends more on images. The latter is usually rich in imagery and feelings. Daydreams, fantasies, and reveries are typical examples. People often engage in nondirected thought when they are relaxing or trying to escape from boredom or worry. This kind of thinking may provide unexpected insights into one's goals and beliefs.

Nature of metacognition: Thoughts are like waves that surge all the time, even when we fall into deep sleep. They are like wild monkeys and horses; the harder you try to tame them, the wilder they become. Without diving into the depths, we will never feel the force with which they drive us. Tomio Hirai (1978) says:

> "The human mind is rarely as calm as an untroubled body of water. At almost all times, ripples or waves of pleasant or unpleasant emotion are disturbing its tranquility. Sometimes, the frequency of these disturbances reaches such a peak that the mind resembles a raging sea in which there is never an ebb tide to bring calm." (p.76)

It is essential that educators identify the existence of drifting thoughts and the everlasting ebb and flow characteristic of the human mind. Unlike those who concentrate their instruction exclusively on metacognitive skills and proceduralize this instruction, I believe the design, instruction and learning of metacognition should incorporate nondirected thinking and creative thinking. The question about whether drifting thoughts interfere with metacognitive thinking, or whether metacognition can potentially impede creative thinking is worth contemplating.

Metacognition and creativity: The essence of metacognitive thinking is more complex than the various versions that have been discussed above. Since metacognitive thinking tends to occur in short fits (Borkowski et al, 1990), when learners first learn to use metacognitive thinking, they are like novice surfers who strive to balance themselves in the irresistible and unpredictable surging currents surrounding them. Their balancing skills have to be developed in the raging surges. Similarly, one's metacognitive thinking has to be developed along with drifting thoughts. Rather than dealing with metacognition as a mental activity separate from others, I would emphasize that we cultivate metacognition not to suppress drifting thought, but to skillfully direct drifting thoughts to metacognition, where creativity can be fostered. However, current literature does not mention how one's metacognition interrelates with creativity.

Although Perkins (1990) argues that there is room for mindfulness and control to play in creative thinking, and that creative thinking can steadily become more metacognitive, changing in character as it does so, he does not take into consideration the relationship between drifting thoughts and directed thoughts. What he proposes is more a matter of integrating the strategic feature of metacognition with creative thinking, namely of extracting the strategies for creative thinking and making them executive and manageable. The complex interplay of the two mental activities are not really investigated.

Metacognition and habitual thinking & acting patterns: Habitual thinking or acting is another variable that competes with the cultivation or development of metacognition. Sometimes, it even plays a more dominant role than drifting thoughts in directing one's thinking and acting. Very often people fail to use metacognition not because they don't know the value of it, but because they are not able to overcome the driving force of their habitual, routinized way of thinking and acting. It is through critical awareness of the dominant role of these thinking and acting patterns that people can rise up from the bondage of these patterns and from the frustration, anxiety or lack of confidence caused by the unsuccessful adoption of new ways of thinking and acting. Then they can extend their visions to a broader spectrum, and the expansion of one's repertoire becomes possible.

Metacognition as critical awareness and conscious action: Although awareness of one's cognitive states was identified as a major component of metacognition (Flavell, 1978; Scarr & Zanden, 1984), the complexity of the concept has not been investigated in the literature of metacognition. At best, it is understood as the knowing of one's mental states, learning process or strategies, behavior regulation, ability or memory. As a matter of fact, there are two types of awareness, internal and external. Internal variables include awareness of personal learning strategies or styles, habitual patterns, abilities, predisposition, and self-efficacy or confidence. External encompasses awareness of to-be-learned metacognitive skills, nature of learning tasks, constituents of learning environment, and perception of differences between self and others in terms of the internal characteristic of awareness. It is important to highlight awareness from the two dimensions and assist learners to understand how their internal processes interact with the external variables in a routinized manner, and how such interaction might be improved in order to cultivate learners' awareness at a more conscious and critical level.

Metacognition and reflection: In order to further understand the nature of metacognition, it is important to distinguish metacognition from reflection. In some way, metacognition and reflection are very similar since both of them involve thinking about one's thinking or doing. Dewey (1933) defined reflective thinking as

> "the kind of thinking that consists in turning a subject over in the mind and giving it serious and consecutive consideration. It involves not simply a sequence of ideas,but a consequence - a consecutive ordering in such a way that each determines the next as its proper outcome, while each outcome in turn leans back on, or refers to, its predecessors." (p.3-4).

As described earlier, the moment-to-moment action required in managing one's learning in a metacognitive activity shares some similarities with reflective thinking. However, rather than a precedent or proactive act embodied in reflective thinking, metacognition requires the present, current thought monitoring, taking the form of momentary and ongoing awareness or mindfulness. It is reasonable to draw the conclusion that when a person is engaged in metacognitive activity, he/she must be reflective. However, when this person reflects upon something, he/she may not necessarily exercise metacognition.

Metacognition as dynamic and spontaneous mental activity: More important, rather than seeing metacognition as a combination of static components, we should be looking into its dynamic interacting process among the external strategies, the internal thought processes in which metacognition is just one, and the interfering unpredictable, continuously waving and drifting thoughts. In other words, instruction and design of metacognition should place as much emphasis on metacognition as on its related thought processes, and be repositioned in a larger learning context.

Developmental processes of metacognition

Given that one's metacognition is developed along with drifting thoughts, and keeping in mind how a novice surfer becomes adept at balancing him/herself in the unexpected surges (as drifted thoughts), I will elaborate in the following section as to how one becomes a person from under and on metacognition, to in, and then of metacognition.

Although most of us use metacognitive thinking in some form or other, we are not necessarily aware of it, because the activity is in our subconsciousness. This is what I call -

under metacognition. When we are under metacognition, drifting thoughts and habitual thinking and acting patterns play very dominant roles in driving our action. We might be metacognitive sometimes, but this appearance is very momentary. Most of the time, our learning strategies are used habitually, lacking a critical reflection of their virtues and vices. Once we come to recognize the existence of metacognition and begin to know the various metacognitive skills, we start the journey to the practice of metacognition, and will be on metacognition. During this stage, strategies play a more explicit role than they do in the previous stage, since most of our attention is directed toward the newly-known strategies. While drifting thoughts and habitual thought patterns are still active, there is more room for the exercise of metacognition. However, our awareness of our own mental states and traits, or use of the newly acquired strategies, and monitoring process are frequently interrupted by various kinds of drifting thoughts. When we enter into metacognition, we are first confined within the framework; metacognitive skills, at the moment, become the focus of our attention. However, we are not able to use them freely although we are taught to or learn to deliberately apply metacognitive skills. While other metacognitive skills, such as critical awareness and reflection are also taking a more active form, these skills are more external than internal. It is not until we can automatize metacognitive thinking that it becomes a natural part of our thinking, and will not impede creativity. Until metacognitive thinking becomes autonomous and used less deliberately, then we will be of metacognition. When we are of metacognition, we will no longer stand inside the circle of ourselves. We can distance ourselves more easily and look into ourselves from a wider angle and more diverse perspectives. Reflection at this stage will become more critical then it is in the previous stages, since the self is elevated from the original lower point. Although drifting thoughts and habitual patterns of acting and thinking might occur sometimes at this stage, we can direct these interfering thoughts, confronting them with more positive attitudes by searching for the rooted problems more clearly, and convert these thoughts into forces of improvement. In general, the process is not linear, but cyclical. Even after we become of metacognition, we might be under metacognition for short moments when our mental states are under great impact.

It is important to identify where a learner stands in this process and provide appropriate instruction accordingly. Because metacognitive development takes time to cultivate, neglecting these stages will result in futile efforts concerning instruction and design. It is also essential to incorporate instruction and design of instruction with such acquisition processes, giving full consideration to the various concepts relevant to metacognition. In other words, the design of metacognitive instruction should be integrative with the learning process, and be compatible with other thinking and acting processes. How one proceeds from novice to expert of metacognition and what roles the reconceptualized components of metacognition play in this process are the important considerations teachers and designers should take into account in order to make instruction rigorous.

PRINCIPLES OF METACOGNITIVE INSTRUCTIONAL DESIGN

Levels of empowerment

Generally speaking, there are several levels of empowerment. For example, empowerment can take place at the personal, interpersonal, organizational, or societal level. No matter which level it might occur, it will definitely influence other levels to a certain extent. Apparently, the developmental process of metacognition seems to belong to the personal psychological level. However, the essence of empowerment through metacognition is to make changes in one's thinking and ultimately action. When people at each level become more metacognitive, empowerment will simultaneously occur at the various levels, which in turn makes the environment more favorable to the fostering of metacognitive development.

Instructional principles of empowerment

Pluralistic spirit: The first principle of empowering learners through metacognition is that instructional and design must have a pluralistic spirit, since metacognitive thinking differs from one person to another. However, instructional designers have been working in a mode of totality, certainty, and control. Giroux (1988) points out that educational theory has been strongly wedded to the language and assumptions of modernism. Within the discourse of modernism, knowledge draws its boundaries almost exclusively from a European model of culture and civilization. According to Lyotard (1984), postmodernism is a rejection of grand narratives, metaphysical philosophies, and any other form of totalizing thought. The challenge of postmodernism is important for instructional designers because it raises crucial questions regarding certain hegemonic aspects of modernism and, by implication, how these have affected the meaning and dynamics of our practice. In recent years, more and more educational technologists have recognized that the standardization mindset of the industrial age should give way to the diversity mindset of the information age. For example, Benathy (1991) states that the prevailing educational design-which is rooted in the industrial model of the last century-cannot be improved or restructured to meet the requirements of the post-industrial information/ knowledge age. We are called upon to envision new images of education and, based on them, design new systems of learning and human development which will prepare future generations for the challenges of the new era, and empower them to shape their own lives and the life of their society. It is my belief that instructional designers should recognize the plurative reality in the postmodern era and think metacognitively during the design process in order to broaden or even break the boundaries that prevent them from designing creatively.

Such pluralistic spirit will be best presented if instructional designers identify learners' multiple ways of knowing, recognizing the various human beings' intelligences without favoring only some of them (Gardner, 1985). When designing instruction, one of the instructional approaches is multiple ways of teaching. There is no best instructional strategy, but only most appropriate for certain types of learning tasks, ones for certain group of learners, and under certain circumstances. Instructional design should embrace multiplicity, rather than optimality. Taking analogy as an example, a pluralistic way of designing instruction with analogy would not only be multiple analogies for a variety of contexts (Wilson & Cole, 1990), but also analogies that can accommodate the cultures of diverse groups of learners, using the language and social norms familiar to the learners. In other words, analogies should not be formulated at the abstract or conceptual level. Instead, it should be integral with the target learners' culture.

Resolving the boundary: The second principle is resolving the boundary. Instruction and design of metacognition, though they can be initiated or undertaken from the content of metacognition, are not a self-independent activities. The first step for us to resolve the boundary is to unlearn what we have learned because we are often blinded by what we have known, rather than what we don't know. The second is to approach a task from as many angles as possible. For example, metacognition can be regarded from cognitive, affective or behavioral aspects. It can also be studied with creativity, critical thinking, problem solving etc. In the section of reconceptualization of metacognition, I have demonstrated some of this spirit. Limiting the design or instruction of metacognition simply to the content of metacognition will result in rigidity and inflexibility. This is to see a task ALWAYS as a part of something.

Divergent inquiry: In order to empower learners, inquiry should take divergent forms. Any point could be the best cutting point for instruction and design as long as it leads to the goal. Where the starting point of inquiry should be all depends on the learners' metacognitive stage and level, needs, and most important of all, teachers' (designers) knowledge, personality and capabilities. It is important that instructors or designers identify where they and the learners are standing in the process of metacognitive development, and understand the most difficult metacognitive skills that confront learners or themselves in order to determine the focus of instructional emphasis. It is also essential to explore the dynamics of their and learners' development in the process since metacognition is an ongoing mental activity. Learners should be exploring this collaboratively with instructors, or instructional designers should be looking into this with instructors. Because learners of the same group might be in various stages of metacognition, instructional guidance and support should vary accordingly. Inquiry approach for people under metacognition could be more direct and concrete, whereas for those of metacognition, it could be less strategic.

In addition, inquiry can be an inside-out or outside-in approach or other kinds. For example, an instructional strategy can either direct learners' attention first to his/her own drifting thoughts, examining how they influence their learning, or it can focus on learners' task performance, tracing back to the interfering factors. It can also be inquiry of others, which illuminates understanding of self. Divergent inquiry strategies could ensure both the breadth and depth of multiplicity and reflectivity.

Treasuring mistakes: The essence of empowering learners through metacognition lies in its capability of turning drifting, disturbing and interfering thoughts to positive, guided, generating and even creative thoughts. Therefore, instruction and design of metacognition should value mistakes and misconceptions, and distorted ideologies for they are the sources from which possibilities of change arise. All of these sources should be highly valued and be traced back so that rooted problems can be explored. Teachers or instructional designers tend to value strengths more than weaknesses and correctness more than mistakes in the process of instruction. Many instructional models emphasize how to make the best use of learners' strengths in order to motivate them or enhance their self-confidence and motivation. However, there is no instructional approach that is a cure-all. In many cases, people need to be aware of the internal and external obstacles that inhibit their progress. Instruction and design of metacognition should make these explicit to learners.

Strategy-reflection: For this principle, instructional designers or teachers are not to reflect how well learners have performed through certain strategies. The focus is not the learners' learning achievement, but the instructors or designers themselves. Instructional design is not merely the design of a learning task. It is how designers SEE the to-be-designed task and users/learners. It is embedded in teachers' (designers') knowledge, values, experiences and some hidden ideologies and presumptions. For metacognition is a more abstract concept, which takes one form or another in everyone's mind, the strategy-reflection principle should be directed to reflect the values, assumptions and ideologies that are embedded in the way we teach or design. By doing so, we can be emancipated from our confined limited knowledge of learning, instruction and design.

CONCLUSION: A REMARK ON DESIGN

In this paper, I have proposed a new perspective for designing metacognition, drawing both upon how human beings acquire metacognitive skills and how these skills are interwoven with other thinking skills. It helps us investigate how the acquisition of metacognitive skills could be coordinated with appropriate approaches to teaching, guiding and enlightening learners about these same skills. An instructional designer should bear the dynamic and integrative nature of metacognition in mind, so that the actuation of learning, instruction and design possibilities can be attained. In other words, the instruction and design of metacognition should be integrated with the nature and development of one's metacognition.

Traditionally, learning theories, instructional theories and instructional design theories are treated as three distinct entities. Numerous arguments about whether instructional theories can stand alone from learning theories have been made. Recent exploration of Constructivism has provided a great deal of insights into the possibilities of integrating the two. Nevertheless, current instructional models of metacognitive thinking do not incorporate the learning process of metacognition. They are procedural-oriented, neglecting the dynamic process and the holistic nature of mental activities because of the problematic definitions and their narrow view of the function of metacognition. Since metacognition is taught without being integrated with other thinking skills, creativity and ease of learning may be often sacrificed.

It is not until learners, teachers and designers all engage in the roles they play that a learning-centered environment becomes possible. Teachers need to play the role of facilitator in order to guide, rather than control students' learning. They should never cease to be learners if they wish to master the art of teaching. Instructional designers, who have taken for granted that their knowledge of instruction exceeds that of teachers, need to reflect on the complex interactions between learning and instruction. More important, learners need to be given the responsibility to direct, manage or even design their own learning. When they become teachers of themselves, they could be more creative. In addition, teachers' metacognition will enable them to perceive their instruction in a more reflective, dynamic way; instructional designers', together with learners' metacognition, will allow them to make better decisions about the kinds of instructional and learning activities appropriate for learners.

The mission of instructional designers is to enable teachers to design instruction metacognitively that will in turn empower students to design learning for themselves. Empower teachers and we empower learners. In a learning-centered environment, instructional designers will be the backstage heroes, assisting learners and teachers to become the main actors of the learning drama.

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Title:

Configurational Inquiry
Instructional Development Perspective

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Introduction

The field of instructional technology is in transition. During the past few decades, the arrival of the information age has had a profound impact on the field. The most visible change has been the dramatic development and extensive availability of computers and telecommunications technologies. The concepts, applications, and resources developed from these technological advances when applied to the field greatly stimulate our imagination and promote our capability of solving instructional and learning problems.

These technological advances also allow us to think beyond public and higher education. More and more IST graduates and faculty members are taking jobs and consulting in nontraditional educational contexts such as corporate development, government training, health care institutions, and other such areas. In short, the field of instructional technology is dynamically expanding its clientele. While there are more possibilities and opportunities being generated, at the same time there are more responsibilities to consider.

In order to run our business more effectively and wisely in the new era, we need to have a new perspective which can furnish new guidelines. This paper is thus intended to synthesize the promising instructional development perspectives into a current set which might be discussed by the profession at large and might highlight new directions for the field.

In Search of a New Perspective:

Davies (1982) argued that instructional development can be best understood as a set of criteria and he contended that each process of instructional development must contribute to these criteria. The final results should be well integrated into people's lives and be concerned with not only their behavior but also their cognitive processes. That is, instructional development is concerned with worthy human performance and healthy human development.

In this paper, the authors propose an integrated set of criteria entitled "Configurational Inquiry Instructional Development Perspective " (CIIDP). By the term "configuration," the authors mean the structure and arrangement of a certain system and of its functional processes. The word configuration also implies that the vigorous interrelationship and interaction of the elements existing in that system. The term "inquiry" usually denotes a quest or investigation for knowledge or truth. Nelson (1976) interpreted inquiry as a means, whether scientific or philosophical, utilized by investigators to be fruitful; that is, it is used to solve inquirers' problems through a thorough investigation toward the research target. In short, "configurational inquiry" means that a thorough detection, diagnosis, and appraisal of a variety of human or non-human systems in terms of the structure, arrangement and interrelationship so as to resolve the inquirer's problems.

The CIIDP encompasses four features which include (1) systemic thinking as its structure, (2) interdisciplinary approach as its path, (3) human-based inquiry as its heart, and (4) improving interfaces as its top task.

First of all, instructional development is not a concept like mechanics -- it is more like liberty (Davies, 1982.) The exploration of a complex concept such as liberty thus requires the use of a more sophisticated method such as the holistic nature of the systemic approach. Therefore, one of the determinants for an instructional developer to succeed, the authors assert, is to undertake a systemic inquiry of the configuration of various ID processes.

Second, instructional development could be regarded as an activity to facilitate human development through the improvement of instructional and learning process. However, human development is so complex that adequate understanding cannot result only from one specialization. In other words, the need of an interdisciplinary approach for instructional development is needed in the areas of theory and practice. One of the purposes of this paper is to remind and encourage practitioners of instructional technology to rethink the roots of our field and to enrich these roots through the inquiry of the configuration of polydisciplines.

Third, instructional developers are social activists in scientists' clothing who mainly perform their jobs among people (Schwen et al., 1984). The jobs are basically a task of human-based inquiry which involves a great deal of interaction, communication, and negotiation within and among the various human communities. The authors argue that instructional development should be neither instructor- nor learner centered, but rather human centered. By human-centered, the authors mean that all significant members of the ID process are taken into account. An appropriate exploration of the configuration of a given human society thus becomes another significant element in the ID process.

Finally, in order to optimize the development of instruction, we need to polish the interfaces among all identities involved in the process. These interfaces are composed of various gaps and obstacles. In order to resolve instructional/learning problems, we need to overcome these barriers, so as to improve these interfaces. In other words, we need an inquiry of the configuration of diverse interfaces toward the optimal organization of instructional systems.

Systemic Thinking as Its Structure

Davies (1991) compared two product planning strategies, parallel development vs. serial development (see figure 1), and explored why instructional developers need to adopt the parallel development method. He illustrated that adopting a parallel development approach enables us to reduce the cycle time, remove the number of interfaces between the ID functions, and conceptualize the ID process as an art rather than an engineering activity. In essence, the parallel development method is a systemic approach, and the serial one is systematic.

Insert Figure 1 Here

In addition, the authors contend that the followings can complement Davies's notion and make it more complete. Since a systemic approach is based on social logic and adopts the limited rational philosophy, it thus is closer to the social reality. On the other hand, a systematic approach is based upon scientific logic and adopts an absolutely rational concept, so it is suitable for highly controlled experimental situations. While a systemic approach optimizes feedback and accelerates revision, a systematic sacrifices feedback and slows down revision. A systemic approach places greater emphasis on the dynamics of participation; however, a systematic approach lacks a cooperative climate among the participants. A systemic approach gives us more choices which makes the process more personalized; in contrast, a systematic approach formulates a set of rigid procedures which inhibits our creativity and imagination.

The discussion of systematic and systemic methods among instructional technology professionals is not new. While most of them focus upon the differences and application between these two perspectives, there is little in the literature that examines their relationship. In order to synthesize and make a connection among these contributions, the authors argue that the systematic approach, in fact, can be regarded as a subset of the systemic approach. By adopting this concept, we can formulate a particular strategy according to a specific time at a specific place. We hold highly tuned analytical knowledge and skills which make our performance artful. We thus can make a wiser and more realistic decision in light of the situation encountered.

For instance, when the circumstance is less freedom or the scenario is a pedagogic one, especially when there are low-level skills to be taught, we can accordingly construct a highly structured procedure to develop instruction because such a systematic approach gives people basic skills and it is easy to follow. Devising a military training program is a case. On the other hand, we can also conduct an ID process like rapid prototyping (Tripp et al., 1990) to meet a certain client's request. Such an alternative strategy is especially suited to a decentralized client system in which instructional developers and clients work together in a participative, interactive mode. To work with a systemic approach, we rearrange, or sometimes remove, and prioritize instructional development phases accordingly to optimize our efforts; that is, we work in a flexible manner.

Instructional development is a dynamic activity which involves a myriad of decisions and judgments. Adopting a systemic approach enables us to quickly penetrate the problems and make accurate judgments and wise decisions. This adoption is especially meaningful in the information age which is both content and context rich. In addition, a systemic approach facilitates implementation, liberates the structure, pays attention to the relationship and interaction of all involving participants, and focuses upon the matters of elegance, effectiveness and efficiency. All of these meet the contemporary demands of an instructional development activity in terms of both theory and practice.

Bhola's (1991) notion regarding this issue is particularly relevant: "the systematic is merely a scaffolding for developing a socio-logic; a systemic of purposive action that, in the real world of practice, can accommodate, the emotion, the intuitive, the reflective, the social and the structural." The advocacy of a systemic inquiry of the configuration of instructional development process now seems both appropriate and timely.

Interdisciplinary Approach as Its Path

The nature of instructional technology is eclectic. People in the field come from diverse disciplines and have varied expertise to offer. Although the concept of the interdisciplinary approach is not new to our field, it has been largely overlooked. When performing an instructional development task, we usually stick to our own paradigms and use our own expertise in problem solving with little objective observation and unprejudiced analysis. We have failed to think globally and to make connections among our multifarious and profound competencies.

In the field of instructional technology, specialization is still needed at certain levels, but innovative solutions cannot be created by merely one specialization. That is, by looking at multiple perspectives, we can secure the benefits which are generated from shared and wise solutions. The cooperative interaction between diverse disciplines can complement and extend the development of new knowledge and its application to the field. The interdisciplinary approach can help us investigate known systems in a creative search for new systems which will invent new problems; that is, this approach allows us to go beyond problem solving to a level of problem finding.

Working in an interdisciplinary approach is to perform our jobs within a semiotic framework which can be illustrated as: thesis --> anything else that seems appropriate (including anti-thesis) --> synthesis. For example, what can instructional developers learn from a professional landscape photographer? What competencies of a basketball player are worthwhile for us to master? What characteristics of a marketing manager can be of benefit to us? A professional landscape photographer's love of his/her subject and the ability to simplify the complexity and to anticipate the optimal arrangement; a basketball player's superb skills, flexibility, energy, and a keen reflex; and a marketing manager's ability to recognize the maximum entry point to the identified target, and a sensibility to the sophisticated reality and a holistic view--all of these, can be of benefit to us when performing our jobs. By doing this, we can maximize our strengths, experiences, and resources. The combined efforts may also contribute added dimensions to our research and applications. The convergence of independent ideas is viewed as being more substantial than ideas would have been singularly.

In addition to providing the combined efforts, an interdisciplinary approach as the path of instructional development has another implication. It encourages us to think outside of "the box"; that is, it urges us to be sensitive to the surrounding environment and to think globally. Schwen (1988) indicated that the most significant determinants of our professional futures are outside of our control in many ways. Outside our control does not mean that we should disregard these factors, instead it implies that we must be quite sensitive to these social, physical, and intellectual contexts and forces. Being sensitive to the environmental reality means that we should view reality as the complete interdependence and nonseparability of variables. In other words, we should treat these uncertainties as a characteristic of problems and resolutions. Being sensitive to the environmental reality also means that we should become more open to alternatives and integrate contradictions into an all-inclusive whole which is a basis of reality. A wise application of the environmental influences would empower us in terms of elegance, effectiveness, and efficiency.

Studies on humans and their societies necessarily transcend discipline boundaries. Batts (1985) indicated that whenever knowledge is to be used interpretively or applicatively, curriculum content will tend to be determined by real-life situations, and the network of ideas, concepts, patterns, or relationships pursued will be largely determined pragmatically. While the practice of an interdisciplinary study facilitates knowledge transfer, an application of interdisciplinary approach enables instructional developers to proact and react in the reality. A thorough inquiry through an interdisciplinary approach helps us anticipate potential obstacles (for elegance), reduce the cycle time (for efficiency), and identify more opportunities (for effectiveness).

Human-Based Inquiry as Its Heart

In order to optimize the instructional development process, a human-based inquiry is needed in terms of theory, practice, and our role. Education is not about something casual, but about the proper way to live. Schools are not places for preparing children for life, Davies (1976) argued, they are life themselves for children, teachers, and parents. He went on to claim that we need a people-oriented school, rather than a child-centered or teacher-centered one. Davies (1982) further argued for a shift of instructional development movement. He claimed that the new generation of instructional development is both organic and human in its orientation. It is concerned more with values, situations, choices, and roles which mainly result from human inner thoughts and outward responses. It respects diverse individual's experience, background, and culture. It also implies a need of human-based inquiry to create a human-centered learning environment.

When examining our role, Schwen et al. (1984) indicated that instructional developers are social activists in scientists' clothing. The implication of this is twofold. First, clothing reflects the image which we reveal. Clothing also signifies the methods, tools and strategies which we carry and employ. We dress up and apply the scientific methodologies and tools to address the human learning and performance problems. Second, it indicates the essence of our role; that is, we are social activists who mainly perform our job among people. The job is basically a task of human-based inquiry which involves a great deal of communication, interaction, and negotiation within various human communities.

Banathy (1991) supported this standing point by claiming that we have seen the emergence of four generations of design approaches to human activity systems. While the first generation of design is a "design by" approach, the second "design for", and the third "design with", the fourth generation is an approach of "designing within." Banathy contended that to be authentic and sustainable, human activity systems must be designed and accomplished by the creative participation of all people in the system; that is, it should reflect their collective vision of humanity. Such participation, Banathy went on to argue, enables people to better understand their system and their role in it. It also generates consensus among those who participate, and further ensures that people will take part more effectively and with a deeper level of commitment in the implementation of the design. He encourages every community member by stating that designing our future is our responsibility and we should take charge of shaping it. This responsibility should thus fall on each of us: instructional developers, learners, instructors, and other community members. This understanding enables self-determination and respects the autonomy of the community. It also bestows on the community a unique self-guided and self-directed life. In short, the "design within" approach gives the community ownership.

In order to bestow ownership, we should conduct instructional development activity within the client system and involve all people who are in it, who use it, and who are served by it. Therefore, we need to have a human-oriented instructional development model which is grounded by a thorough human-based configuration inquiry; that is, it should be central to the innate potentialities of human beings. Theoretically, the heart of this model should be grouped with a set of people including the learners, the instructors, the content experts, the instructional developers, and other contemporary life such as the school administrators, corporate personnel in the community, and learner's family, friends, etc.

A human-based inquiry can enrich ID process in many ways. For instance, the curriculum revision project conducted by Indiana University, Instructional Systems Technology Department (1989-1992), provides a good example in applying contemporary life to identify reality. During the initial needs assessment, a pool of IU IST graduates and contemporary practitioners in the field actively assisted in identifying the "real" needs such as more emphasis upon communications skills, better preparation in understanding the "bottom line" of the business environment, and more exposure to and "hands-on" experience with the emerging technologies. The IU IST Multi-Media labs sponsored by the Apple and AT&T Corporations also demonstrates how contemporary life can play a worthy role on information provider and resource linker.

In addition, the establishment of the NASDC (The New American Schools Development Corporation) illustrates the benefit of alliance of business and education (Reigeluth, 1991). The NASDC was formed by business leaders with the hope of reinventing American education by designing new schools for a new century. It is an independent, non-profit organization that is expected to raise roughly $200 million from the private sector to underwrite the design of a new high-performance educational environment.

Moreover, the effort and achievement of "Education 2000" in the United Kingdom give us another persuasive instance to incorporate a human-based inquiry into the practice of instructional development. Education 2000 was formed in 1982 by a group of individuals from education, industry, and commerce. Its aim is to reshape education to meet the present and future needs of individuals within the society. At present, there are nine Education 2000 learning communities established in the UK. These communities all have around 65,000 residents and the project involves all of the schools and all community members. Strong community involvement (as the stimulus for change), curriculum revision (as the means for the change), and technology innovations (used to support the change) are its basic approach.

As indicated above, the process of instructional development is the collective challenge of people in the community. If we want our contribution to be significant, productive, and useful to our society, intelligent strategies should be devised. The strategies suited to this perspective include dynamic participation, flexible grouping, team collaboration, experience connecting, resource linking, discipline integration, creativity development, and responsibility taking.

Improving Interfaces as Its Top Task

While the term "interface" generally means the space where humans and machine meet, the authors interpret it as an area in which diverse systems contact, communicate and interact. In addition to human-machine interfaces, there are also a variety of interfaces existing between different machines or different human groups. For our purpose, this paper will mainly address the latter which varies in names such as perception, experience, belief, value, norm, and culture. .

Our society is undergoing massive changes as we become more effected by the information age. These changes, in such an environment, can be viewed as having a rearrangement of roles, relationships, responsibilities, functions, opportunities, and boundaries within or among various human societies. We modify or reform the old system in order to adopt changes, but, on the other hand, we need to maintain a certain amount of harmony as the changes may result in conflicts. To keep harmony is to make contacted interfaces compatible.

These interfaces are always composed of reasonable amount of, if not many, gaps and barriers. In order to adopt changes to resolve problems and maintain the needed harmony simultaneously, we must identify, prioritize, and overcome these obstacles; that is, we need to improve these interfaces in terms of major functions and major roles. The authors hold that the greatest success in our field will result from improving these interfaces rather than from a dramatic breakthrough in hardware. After all, technology must be accessible to be useful. Improved interfaces can bridge a variety of human or non-human obstacles in order to maximize the access and potentialities of technology. The success of instructional development depends upon a synthesis effort to perfect the interfaces among those factors involved in the entire process. In other words, we need a thorough inquiry of the configuration of diverse interfaces toward the optimal organization of instructional systems.

Arnn and Strickland (1975) remarked that frequently strategies which seem excellent on paper fail to produce the desired results, because they lack the consideration of human obstacles. The possible obstacles, according to Gentry and Trimby (1984), include:

-- Gatekeeper rejection after an ID project is underway
-- Client misinterpretation of ID project goals and activities
-- Incongruities within a client organization
-- Loss of momentum after initiation of a project
-- Conflicting expectations within the client group
-- Raids on resources previously committed to an ID project
-- Unclear Client/Developer lines of responsibility and authority
-- Difficulty in obtaining essential information

A task of interface-improving must be performed throughout the whole activity of instructional development. The authors thus view interface-improving as a continual psychological and physiological process. The strategies associated with this process include obstacle removing, obstacle rearranging, and obstacle transforming or a combination according to the nature of the obstacles.

Obstacle Removing: Whenever encountering obstacles, the first thing that usually comes to mind is to remove it or to handicap its influence. Strategies such as promoting communication, redesigning facilities, supplying adequate materials and tools, outfitting appropriate and timely information or feedback, making the ID process more interesting and rewarding, or providing proper training or education, can remove, or at least reduce, a certain amount of obstacles.

Obstacle Rearranging: For those obstacles which cannot be easily removed or need to be kept for some reason, we may want to rearrange them in order to decrease their impact. It is worthwhile to remember that an organization may derive a dynamic spirit from the existence of certain obstacles. A delicate rearrangement and management of these obstacles will positively facilitate our performance. Flexible teambuilding according to the tasks, more appropriate personnel selection and assignment giving, or work flow and load redistribution, are tactics identified in this approach.

Obstacle Transforming: Many unsatisfactory performances result not from human factors, although sometimes they do, but rather the organizational structure does not function as we expect . These obstacles which handicap human performance exist in the contexts such as an organization's personnel structure, operant management, information flow, and identified culture which cannot be simply removed or rearranged. They need to be transformed. In order to transform these obstacles, we need to reform the personnel structure, change the management practice, redesign the information flow, or alter organizational culture, norms, and beliefs. Breaking customary thoughts and practices is the key to transform this kind of obstacles.

A five-year transition plan to whole language in grades K-8 proceeding in the Westwood school district, Massachusetts, provides a concrete example for this situation (Gursky, 1991). Being aware that a piecemeal change cannot result in true improvement, Superintendent Robert Monson, seconded by a teacher-led reading committee, restructured the school system which move away from basals and standardized tests toward literature reading and alternative forms of assessment. In addition, the restructuring effort of Skowhegan Area Middle School, Maine, is another instance (Norris and Reigeluth, 1991). Under the plan of schools-within-a-school, innovative instructional activities are being implemented out to meet students' needs such as a more flexible schedule, multi-grade grouping, and so forth. Transforming the traditional schooling obstacles and providing a better interface for students to meet their individual's needs greatly facilitate leaning.

Improving interfaces is an endless job. It also is an exploration into the nature of both human beings and the world we are live in. Many decisions made in the pursuit should be aesthetic, experiential, and phenomenological. This pursuit also reveals the beauty of instructional development as an art. The understanding and application of interface improving as a vehicle to facilitate human development and improve human performance is a process of continual refinement. Not only do we wish to make contributions, but also we want to make them effective and efficient, elegant and graceful.

Synthesis

The Configurational Inquiry Instructional Development Perspective stresses that we need a thorough inquiry into the configurations of polydisciplines, various ID processes, human societies, and diverse interfaces in order to achieve an optimal organization of instructional systems. The inquiries into manifold configurations further implies that instructional development should be an activity of process emphasizing, goal focusing, dynamic participation, interface improvement, resource linking, discipline integration, responsibility taking, and glory sharing.

Banathy (1987) indicated that an instructional development activity, in its practice, is a process of feedback-feedforward and divergence-convergence. In order to shape development images, we oftentimes go back to previous formulations and re-explore the impact of the emerging resolutions upon the identified problems, but, on the other hand, in an anticipatory mode, we move forward and speculate about the effect of current design and choices which are still ahead of us. In addition, we call for exploring more alternatives in the beginning, and, as the activity proceeds, continuing to search for opportunities to make changes as we gradually converge toward the resolutions. The dynamics of divergence-convergence are revealed while the developers continually go through alternating sequences of generating variety and reducing variety, while seeking the most feasible alternative.

As figure (2) illustrates, an instructional development activity should be quite sensitive to the environmental influence such as the social, physical, and intellectual forces and contexts surrounding the identified systems. These external powers provide diverse realities and uncertainties to facilitate or obstruct the instructional development process. Both learning objectives and human or non-human obstacles are milestones. The instructional development components are the journey. These process components such as management, analysis, design, development, implementation, evaluation, and revision are carried out through iterative cycles as we examine and re-examine the centered human-base and their goals. When we reach each specific objective or overcome a particular obstacle, the milestone becomes part of the journey and we can then move beyond that. These recurring spirals are continually ongoing which bring forth progressively more refined characterizations of the system to be developed. This also is a process of negotiation among involved identities with different viewpoints and values in order to work out a mutual resolution. As Banathy identified, dialectics is the underlying philosophy of this approach, and consensus-building methods provide the technology. Through this participatory process, integrated vision could be established, interfaces could be improved, and, the most important, we would arrive at wiser decisions.

Insert Figure 2 Here

While we accept cultural pluralism as a viable societal arrangement and experience diversification of life-styles, this perspective provides us an organic framework which places a great deal of emphasis upon the full development of human potential and their cooperative interaction. This perspective is both synthesis- and decision-oriented. This is a dynamic model. This is also a model of growth.

Conclusion

Progressing from "The Age of Uncertainty" (1977), what inspiration does Galbraith's philosophical transcendence of "The Age of Pragmatism" (1992) bring to us? Pragmatism implies that we work without a restricted paradigm. It also implies that we are flexible when we work with a given reality. An attitude of respect toward societal pluralism is needed to make decisions in terms of maximum usefulness in order to achieve our goals and satisfy our needs.

There is no single best way to develop instruction, Davies (1984) claimed, appropriateness is the key issue. Working without a restricted paradigm is the first step in identifying appropriateness. Appropriateness is not determined by the developers, instructors, or learners, but rather by the the whole human community. They interpret our messages in the context of their own experiences and knowledge, and construct meaning relative to their own needs, background, and interests (Jonassen, 1991).

Pragmatism also signifies an attitude of "complex in mind, but simple on hand" as we communicate with our clients and learners, especially during the initial stage. On the one hand, we regard the complicated realities and capricious environmental factors as our opportunities and integrate diverse contradictions into an all-inclusive whole. On the other hand, we might want our language and tools to be as simple and compatible as possible since, by doing this way, a mutual trustworthiness between the innovation and adoption systems could be easily established and a sense of accomplishment would also be developed. This attitude further suggests that we should be aware of our benefits and limitations. By knowing our strengths and weaknesses, consequently, we would arrive at more precise decisions.

The elements of the Configurational Inquiry Instructional Development Perspective are not new, but the synthesis of these elements does provide a new orientation and offer an appealing focus. Due to its inner complexity, the authors suggest that a pragmatic attitude should be held while adopting this perspective. In addition, the authors also believe that the significance of this perspective meets the contemporary needs which illuminates not only what the instructional development should be, but also how inquiry into the instructional technology field should be undertaken.

In closing, the authors would assert that while our field is in transition, we all have real opportunities and responsibilities which are essential to our growth and development. The Configurational Inquiry Instructional Development Perspective functions as a catalyst to facilitate this growth and development.

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Serial Development	Parallel Development
Relay race tactics	Scrum & scramble tactics
Move in defined, structured phases	Work in flexible & dynamic system
Functions compartmentalized	Functions overlapping
Poor interface between design & production	Ensures product designed for production
Poor communication between between functions	Excellent communication between functions
Flexibility limited	Flexibility great
Longer product planning cycle	Faster product planning cycle
Design product to last life of costly tooling	Design flexible tooling for each product generation
Limiting speed of response to changing market	Enables speedy response to changing market
Greater risk product will fail in market place	Reduced risk product will fail in market place
Low chance of fast product start-up	Good chance of fast product start-up

Figure 1: Product Planning Strategies

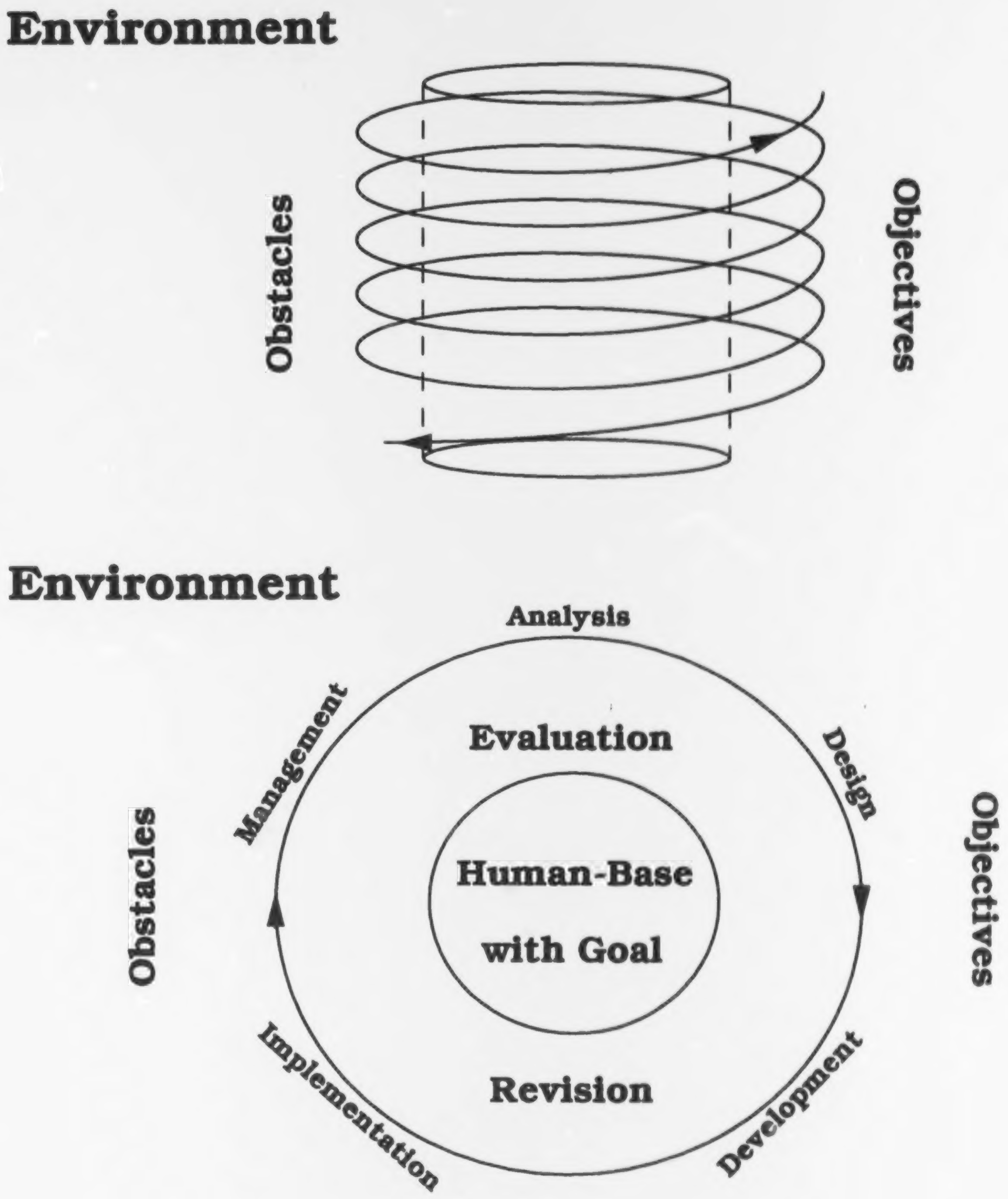
Environment
Obstacles
Objectives
Environment
Analysis
Management
Evaluation
Design
Obstacles
Human-Base
with Goal
Objectives
Implementation
Revision
Development

Figure 2: Configurational Enquiry ID Model

Title:

Teaching Self-Regulated Learning Strategies

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Teaching Self-Regulated Learning Strategies

Learning is a complex process, one which many students, despite years of schooling, still find mysterious (Thomas & Rohwer, 1986). What distinguishes the successful student from his/her less successful peers? A growing body of literature supports the notion that optimal academic performance is strongly tied to the degree of self-regulation the learner is capable of exercising (Borkowski, et. al., 1990; Jones & Idol, 1990; Zimmerman & Pons, 1986; Zimmerman, 1990). Although the self-regulated learning perspective is not, from a theoretical position, a unified one, according to Zimmerman (1990, p.4), "a common conceptualization of these students has emerged as metacognitively, motivationally and behaviorally active participants in their own learning." In other words, self-regulated learners are purposive and goal oriented (proactive rather than simply reactive), incorporating and applying a variety of strategic behaviors designed to optimize their academic performance.

While many students, barring those who are totally tuned out, are, to varying degrees, active in the manner just described, self-regulated learners appear to be both more keenly aware of the relation between specific behaviors and academic success and more likely to systematically and appropriately employ such behaviors (Zimmerman & Pons, 1986). They also exhibit greater flexibility in adapting to the variable and sometimes uncertain demands that exist in the classroom, particularly at the high school and college levels. Nevertheless, the component skills that comprise self-regulated learning need not, in our opinion, be viewed as either exotic or as something above and beyond "the basics." They are in all likelihood *the* basic skills that underlie all forms of successful learning (Resnick & Klopfer, 1989). In any event, given the degree of success that self-regulated learners have been reported to enjoy, it follows that understanding the behaviors and processes that underlie self-regulated learning, as well as designing instruction in ways likely to facilitate self-regulation of the learning process, represent important goals for educational researchers and designers.

Our own research, at this juncture, has not been primarily theoretically motivated. However, after reviewing the literature surrounding this topic, we found it useful (and to some extent, necessary) to impose an organizational structure, in the form of a model, on the various and tangled dimensions of self-regulated learning as reported. Our working model of self-regulated learning presently consists of six dimensions: **Epistemological Beliefs, Metacognition, Learning Strategies, Motivation/Self-Efficacy, Contextual Sensitivity** and **Environmental Utilization/Control** (see Appendix A for a more detailed description). Most of the various self-regulated strategies reported in the literature (for example, see Pintrich, Smith & McKeachie, 1989; Weinstein, Zimmerman & Palmer, 1988; Zimmerman and Martinez-Pons, 1986) fall into one or another of the categories we have constructed. Contextual sensitivity, we should note, although implicit in much of the published literature, is not an area typically identified explicitly as an independent aspect of self-regulated learning. However, the theme that cognitive processes are contextually bound, or "situated" (Brown, Collins & Duguid, 1989; Jenkins, 1974; Rogoff & Lave, 1984) is becoming increasingly general in the contemporary literature on learning and cognition, particularly as it occurs in educational settings. We therefore decided to define it as a separate dimension in our working model of self-regulated learning.

In brief, in developing our model, we reasoned, following Zimmerman (1990), that the self-regulated learner must be able to both internally regulate, monitor, evaluate and modify, when necessary, the learning process, and be alert to and utilize or manage contextual (external) factors such as course and instructor demands, where and when to study, who, when and where to go for assistance, etc. Self-regulated learners are possessed of a belief system that views knowledge as complex and evolving, rather than simple and fixed, and the knower as capable of self-modification. It is also evident that motivational factors mediate the utilization of both cognitive and environmental resources (Borkowski, Carr, Rellinger & Pressley, 1990). Individuals high in self-efficacy, for example, are more likely to use cognitive and metacognitive strategies and to seek appropriate (instrumental) forms of assistance when needed (Karabenick & Knapp, 1991; Schunk, 1991). At the same time, there is a positive relationship between a sense of personal control over learning outcomes and subsequent motivation (Dweck, 1989; Schunk, 1991) to undertake learning-related challenges. Despite the many elements that enter into it, there is, as we shall see, reason to believe that self-regulated learning is a unified process which involves the integration of appropriate beliefs and utilization of cognitive, metacognitive, motivational, perceptual and environmental components in the successful resolution of academic tasks.

Having devised a working model of self-regulated learning, we set out to determine if, and to what extent, self-regulated learning (thus defined) plays a significant role in successful academic performance at the college level. We chose to do this by employing a self-report inventory, of our own design, composed of the subscales consistent with our working model discussed previously. We opted to develop such an instrument because to our knowledge no instrument of its kind existed, and we believed that such an instrument could prove valuable as a research tool and would be more efficient and cost-effective than interviewing.

This paper describes the development of our questionnaire, methods used in collecting data, results of the data analysis, and then discusses the degree which a construct as complex and multi-faceted as self-regulated learning can be measured using a self-report inventory. In addition, the paper discusses some implications of our working model for instruction and teaching self-regulated learning strategies.

Method

Development of the Self-Regulated Learning Inventory

Our first step in the creation of a self-regulated learning inventory involved the generation of an item pool. We decided to review the literature and to construct our items on the basis of findings that reported strong relationships between learner-generated activities and academic success. We then reviewed and analyzed the items eliminating those that were too much alike and rewriting those that were either too complex or too vague. This left us with a pool of seventy-one items all of which were included in our first instrument. Although the items represented each of the subscales of our working model discussed previously, we decided to present them randomly as a single questionnaire. A five point Likert scale format was chosen as most appropriate for this type of instrument.

The instrument included representative items from each of the subscales except the epistemological beliefs subscale. Our first conceptualization of the model did not include the epistemological beliefs dimension, thus we only wrote items for the other five subscales. After analyzing the data presented in this paper, however, we revised the instrument and included 15 items representing the epistemological beliefs dimension. Most of these items were obtained from Schommer's (1990) work in assessing student's beliefs about the nature of knowledge. Appendix B shows sample items from each of the subscales, including items from the epistemological beliefs subscale which we added in the revised version of the instrument following the data analysis of this study. The data analyzed in the following sections of this paper, however, only include data collected with the first version of the instrument, which did not include epistemological beliefs items.

A pilot run was conducted to see if directions were clear and sufficient, how long it took to respond to the inventory and if the items as written were clear and comprehensible. As a result, a formal set of instructions was composed. It was determined that time to complete the inventory ranged from 20-30 minutes.

Subjects

Our subjects were all students enrolled in classes in the college of education at a medium size mid-Western university. Unfortunately, the majority of education majors continue to be female. Thus, our sample contains an imbalance in terms of males (39) and females (121). In terms of ethnic composition, 145 of our subjects were European American (White), 10 were African American (Black), two were Hispanic American and three were Asian American. With respect to class standing, 51 were sophomores, 58 were juniors, and 35 were seniors. Our sample also included 14 graduate students and two non-degree students. The mean age of our subjects was 22.8 years. In total, the inventory was responded to by 166 students. Only 160 cases were actually analyzed due to the failure of some students to properly report requested information and/or respond to items.

Procedure

The inventories were administered in every instance by one or the other of the authors. Having obtained prior permission from class instructors, we passed out the inventories and read a prepared set of instructions. Classes ranged in size from thirty to ten. Although participation was entirely voluntary, no student refused to fill out the inventory.

Results

We first report on findings that relate to the technical properties of the inventory. Table 1 shows the result of an analysis of internal reliability of the five subscales discussed previously (MC represents the Metacognition Scale, LS represents the Learning Strategies Scale, MO represents the Motivation/Self-Efficacy Scale, CS represents the Contextual Sensitivity Scale, and EC represents the Environmental Utilization/control Scale).

We are encouraged by these results, although by no means satisfied. An analysis of test-retest reliability, with an eight week delay between times of testing, revealed a correlation of .78, a result we also take to be encouraging.

Table 1

Reliability Coefficients (Cronbach's Alpha)

	MC	LS	MO	CS	EC
Alpha	.77	.83	.77	.64	.79

Our evidence with respect to validity at this point is mixed. That is, our items were constructed on the basis of findings in the literature related to the construct we set out to measure. An analysis of the correlation between scores on the inventory and GPA, our measure of academic achievement, revealed a significant correlation both for the inventory as a whole (represented as SRLTOT) and for each of the subscales (see Table 2). This result corresponds to findings as reported in the supporting literature and provides evidence of concurrent validity.

Table 2

GPA and Scores on the Inventory

	MC	LS	MO	CS	EC	SRLTOT
Correlation	.41**	.47**	.48**	.31*	.39**	.54**

* p <.01, ** p <.001

The result of a factor analysis revealed that two factors account for the largest percentage (30.4) of the variance. A general factor represented by items from every subscale (in all, 52 of the 71 items) which we labelled self-regulated learning and a self-efficacy factor represented by 13 of the 15 items from that subscale. These two items, as noted, account for the main portion of the variance. The fact that a single factor loads highest is in line with the findings of Zimmerman & Martinez-Pons (1988). However, a number (18) of other factors, small but statistically significant, also appeared. While this complicates our ability to draw clear-cut conclusions with respect to construct validity, we found some of these factors to be suggestive in terms of potential areas of inquiry requiring further investigation. For example, it would appear that some students are instructor-based learners while others are text-based learners. It would also appear that further work on the inventory will need to be undertaken to insure that its items represent fewer, and more distinct factors.

As noted, we selected student GPA as our measure of academic achievement. While scores on the inventory subscales in each case correlate significantly with GPA, the largest correlation obtained (see Table 2) was between GPA and total score (SRLTOT). Analysis of the data with respect to the variables of class, age, and sex revealed significant correlations between both sex (.19 p< .01) and age (.31 p<.001) and total score on the inventory (see Table 3). The correlation between class and score on the metacognitive subscale was also significant (.21 p< .01).

Table 3

Correlation Coefficients

	Class	Sex	Age
MC	.21*	.05	.28**
LS	.07	.21*	.26**
MO	.12	.19*	.26**
CS	.01	.12	.09
EC	.08	.12	.28**
SRLTOT	.13	.19*	.31**

* p< .01, ** p< .001

Table 4 shows the mean scores for males and females on the inventory and its subscales. The maximum score possible for the total inventory was 355, which reports the highest degree of usage of self-regulated learning strategies. The minimum score possible was 71. The maximum and minimum scores for each subscale, respectively, are as follows: MC: 85 and 17; LS: 90 and 18; MO: 75 and 15; CS: 50 and 10; and EC: 55 and 11.

It can be seen that females outscore males on total score as well as all subscales but metacognition. While these differences are, in most instances, statistically significant, we hesitate in drawing any firm conclusions due to the small number of males in our sample. We also found, as noted, a significant correlation (.31, $p<.001$) between age and total score. Older subjects tended to score higher. This result is, in part, due to the fact that the graduate students in our sample, though few in number, generally scored higher ($M = 268.1$) on the inventory than other groups (overall $M = 247.9$). The fact that only metacognition showed a significant correlation with class is somewhat misleading. That is, although there were only 14 graduate students in our sample, their mean age was 32 (mean age overall being only 23). Thus the graduate students were both the highest scorers and the oldest students.

Table 4

Sex X Inventory Score (mean scores)

	MC	LS	MO	CS	EC	SRLTOT
MALE	57.2	61.2	51.4	34.4	35.1	239.3
FEMALE	57.8	65.4	54.6	36.2	36.6	250.6

N for Male= 39
N for Female= 121

Discussion and Implications for Teaching Self-Regulated Learning Strategies

Results of the Inventory

The results provide some degree of evidence which lead us to conclude both that self-regulated learning is an important component in academic success and that it can be measured with some degree of validity and reliability via a self-report instrument. The results of our data analysis indicate a significant relationship exists between self-regulated learning and GPA. This result is in line with published research on self-regulated learning (Zimmerman & Martinez-Pons, 1986; 1988; Zimmerman, 1990). Encouraging as these results may be, however, we also note that although total score on the inventory and GPA did reveal a highly significant correlation, there arose some problems with the use of GPA as a criterion. For example, some students, although not scoring high in terms of self-regulation, appear nevertheless to maintain a high GPA by either avoiding or dropping difficult courses. Hence their scores may actually have served to lower the degree of relationship. Unfortunately, we were unable to obtain sufficient information to allow us to determine which students actually dropped which and how many courses. We plan to gather this information in a follow-up study. It should be noted as well, that although the correlation between score on the inventory and GPA was found to be highly significant, much of the variance in student performance is left unexplained.

The fact that total score showed the highest correlation with performance is in line with the work of Zimmerman & Martinez-Pons (1988), who also found that self-regulated learning treated as a single, overarching factor, showed the strongest correlation with achievement. However, factor analysis of the data suggests that degree of self-regulated learning may be mediated by "learning style" factors not yet clearly understood. The fact that graduate students score highest suggests the greater presence of self-regulated learning in this population. While this is not entirely surprising, the small number of graduate students in our sample makes this finding suggestive only. In general, it can be concluded that self-regulation is a significant element in successful college student performance and that many students could profit by forms of instruction that emphasize and promote both the understanding and use of the component skills and attitudes of which self-regulated learning is comprised.

Implications for Instruction

Our research, as well as the research of a number of others (Borkowski, et. al., 1990; Jones & Idol, 1990; Zimmerman & Pons, 1986) lends support to the claim that self-regulatory skills are important components of successful academic performance. An important question is: what, if any, implications do such findings have for instruction? Before addressing this question, we would like to underscore the importance of the issue by noting that classroom instruction, even at the university level, may not only fail to promote self-regulated learning, but actually suppress it (McCaslin & Good, 1992; Farnham-Diggory, 1990). While self-regulation is important for superior academic performance, academic conditions do not necessarily promote either the use or development of this ability. Having said this, we think at least two implications can be drawn.

First, the fact that self-regulated learning plays a crucial role in academic success indicates that teachers need to assess and take into account this dimension of the learning process when considering the classroom performance of particular students. Academic difficulty may be less a matter of ability than a failure of students to (know how to) take control of the learning process to a sufficient degree. More specifically, the problem may lie in one or several areas directly tied to self-regulation of the learning process. For example, lack of metacognitive awareness and self-monitoring may lead to failure to apply the skills the learner possesses under conditions where they clearly apply (Schunk, 1991). On the other hand, the learner may fail to acquire an understanding of the connection between specific learning tactics and specific learning situations and outcomes (Pressley, et. al., 1990). Some learners may interpret challenging classroom tasks as potential sources of negative evaluation of their competence, hence fail to apply the knowledge and skills they possess (Dweck, 1989). To overcome such deficiencies, it is necessary that learners be provided with information which ties strategy use to specific learning outcomes (Pressley, et. al., 1990). Such information is also likely to provide feedback which links learning outcomes to specific student generated activities, a fact which is known to affect self-efficacy attributions (Schunk, 1991).

A significant contribution of our working model is that it illustrates the comprehensive nature of self-regulated learning and the importance of the critical relationships among its components. With a comprehensive understanding of the different dimensions of self-regulated learning, teachers can assess the particular areas in which students may be deficient and help to remediate these weaknesses. For example, a teacher may assess that a student has excellent metacognitive strategies, such as reflecting and self-monitoring, and also a good repertoire of learning strategies. However, if the student believes that the ability to learn is innate rather than acquired, he/she may choose not to engage in a learning situation because he/she doesn't believe that he/she can acquire the required ability to solve the learning problem, thus never using his or her excellent cognitive strategies. Such relationships and interactions are not identified in many of the traditional study skills models, courses or programs.

Second, it may be necessary, particularly when self-regulatory skills are found to be lacking, to develop instruction specifically aimed to counteract this deficiency. In fact, we believe that since self-regulation empowers students, it should always be a component of the curriculum. In this regard, our thinking is in line with an instructional approach referred to as cognitive apprenticeship (Rogoff, 1990). As Rogoff (1990, p.39) notes, cognitive apprenticeship occurs when "active novices advance their skills and understanding through participation with more skilled partners in culturally organized activities." Cognitive apprenticeship is, in other words, a form of socially mediated instruction wherein (1) to-be-learned skills are modeled by a more experienced "expert" [adult or peer], (2) made explicit by the "expert" through think-aloud demonstrations in the application and regulation of the component skills and (3) over the course of learning the "novice" is induced to accept increasing responsibility for his/her performance of the target skill (Englert & Raphael, 1989). Also crucial to the cognitive apprenticeship model is the notion that socially mediated learning is most effective when occurring within the "zone of proximal development" (Rogoff, 1990). That is, such instruction attempts to enter a student's optimal region of sensitivity to social guidance in order to facilitate cognitive growth. In order to accomplish this goal, one needs to assess the learner's readiness to benefit from a particular instructional intervention. Assessing the ability to self-regulate the learning process would appear, to us, to be an important qualifying criterion.

Our inventory could be used as a diagnostic tool to identify the specific areas in which students have difficulty in self-regulating the learning process. The information provided by the inventory could be used by a teacher as a basis for planning or developing individual instructional prescriptions for both remediation and enrichment. In addition, such information could be valuable for determining the degree to which a particular learner is prepared to benefit from self-instructional materials, including many forms of computer-based instruction. Many students who flunk or never complete a self-instructional course or program fail because they lack the necessary ability to self-regulate the learning process. Perhaps one approach for reducing the failure rate of self-instructional courses or programs would be to administer the instrument to students before taking the course and then adjusting the program or advise students in accordance with performance on the inventory.

Many models for the design of instruction advocate the assessment of the learner's entry behaviors and learner characteristics. However, many of these models only advocate assessing the domain-related knowledge which the learner brings to the learning task. Our working model suggests that educators and instructional designers should not only assess the learner's knowledge base and skills, but should also assess information about the student's epistemological beliefs, motivational level, use of metacognitive and learning strategies, level of contextual sensitivity, and ability to control and utilize his or her learning environment. Given the fact that students enter the learning process at varying degrees of self-regulation suggests that, ideally, a variety of instructional options should be developed to suit the needs of different types of learners.

The Role of Interactive Videodisc-Based Technologies

Considering the evidence that self-regulated learning is an important component in academic success, the next logic question is: What is the best way to teach these higher-order, complex, thinking strategies and skills? Stated more specifically, what are the most effective instructional strategies for promoting both the understanding and consistent use of self-regulated learning strategies?

We propose that an effective and efficient means of tackling the problem involves the creative and resourceful use of interactive videodisc-based technology along the lines of the "anchored instruction" strategy of the Cognition and Technology Group at

Vanderbilt University (Cognition & Technology Group at Vanderbilt, 1990). The basic premise of what the Vanderbilt group refers to as anchored instruction is that learning is most natural and most viable when it is "situated" in realistic environments that permit "sustained exploration by students and teachers and enable them to understand the kinds of problems and opportunities that experts in various areas encounter and the knowledge that these experts use as tools" (p. 3). They (drawing upon the recent work of Allan Collins and John Seely Brown [Brown, Collins & Duguid, 1989], who have been instrumental in advancing the ideas of situated cognition and cognitive apprenticeships) argue that situated cognition provides a broad, useful framework that emphasizes the importance of focusing on everyday cognition, authentic tasks, and the value of in-context apprenticeship training. As Brown, et.al. (1989) have noted, natural learning proceeds most effectively in the context of authentic (rooted in the realistic practices that prevail in a particular culture) tasks. However, given the structure of our contemporary educational system, authentic contexts of apprenticeship for the acquisition of the complex intellectual skills necessary for success in higher education are difficult to create in a cost-effective and efficient manner. Clever use of interactive videodisc-based technology, however, may provide the key for making preparatory educational experiences more authentic.

According to the Vanderbilt group (Cognition & Technology Group at Vanderbilt, 1990), anchoring instruction in videodisc-based problem solving environments has several distinct advantages. First and foremost, it makes the "idea of transforming school instruction into apprenticeships more feasible" (p. 8). It is, in other words, more realistic to ground (anchor) problem solving-based instruction in the simulated reality of a videodisc than to place classes full of students into authentic, real world conditions that require problem solving (e.g., planning, navigating and undertaking a journey by boat, etc.). Videodisc-based contexts also have the advantage of compressing what would take days, perhaps weeks and months in the real world, into minutes and hours in the classroom, as well as making it possible for students to revisit event segments and test their memories against actual aspects of events, something not generally possible in real life. In short, employing videodisc technology holds the potential for making classroom learning more authentic and apprentice like.

The Cognition and Technology Group at Vanderbilt (1990) have, to date, employed the notion of anchored instruction within two key projects. Preliminary findings show very positive results indicating that students so instructed are more likely to employ higher-order thinking than comparison groups receiving more traditional forms of instruction. However, the Vanderbilt group has focused largely on elementary school age children and problem solving skills that might best be characterized as deductive in nature.

Our own interest lies with older, college-age students. Furthermore, the kinds of higher-order thinking skills we wish to facilitate are best characterized as self-regulatory skills. Nevertheless, we believe that the anchored instruction approach using interactive videodisc-based technology is a very promising, viable approach for promoting self-regulated learning strategies.

Design Considerations of Teaching Self-Regulated Learning Strategies

We are currently in the process of designing instruction (using interactive videodisc-based technologies) for promoting self-regulated learning strategies in college students. As a part of this effort, we are conducting a study to determine the most appropriate and effective instructional strategy (or strategies) for teaching these higher-order thinking skills. The instructional strategy, or strategies, best suited to promote a more general acquisition of such skills remains largely an empirical question. Three such strategies can be identified in the literature: the stand-alone strategy, the embedding strategy and the immersion strategy (Ennis, 1989; Prawat, 1991).

The stand-alone strategy assumes that there exists a set of general, content independent cognitive skills, which can and should be taught as such (Feuerstein, 1980). It is, say its proponents, up to the educational community to make room in the curriculum for such instruction. Critics charge, however, that explicitly taught generic thinking skills typically fail to transfer either across the curriculum or to the work place (Larkin, 1989). The embedding strategy is built on the premise that higher-order thinking skills are best taught explicitly as an integral component of content-based instruction (Beyer, 1987; Ennis, 1989). Those who prefer an embedding strategy also assume that thinking skills are, to a significant extent, context bound. From this perspective, the contemporary curriculum need only be slightly modified in order to incorporate instruction that emphasizes the how of learning as much as the what of learning. To critics, however, the feasibility of embedding an emphasis on higher level thinking skills at no cost to the standard curriculum appears questionable (Prawat, 1991). Furthermore, just as with the stand-alone strategy, the problem of cross-content transfer also plagues the embedding approach.

A third, less common and less well-defined approach to promoting the development of higher level thinking is represented by the immersion approach. Essentially, those who promote an immersion strategy argue that higher level thinking will emerge naturally when students' own ideas are taken seriously, and as they are immersed in the main ideas and issues that define a particular field of study (Prawat, 1991). The immersion approach is a content first strategy. However, the emphasis is more on the importance of ideas as tools for unlocking content rather than on either the content per se, or the cognitive processes (independently construed) applied to that content. Importantly, it is thought by its proponents that cross content transfer of the thinking skills emerging out of students' confronting the main ideas that drive a discipline is more likely with the immersion approach because they arise implicitly and naturally (rather than explicitly and artificially) in the process.

It can be seen that proposals for the remediation of the failure of education to promote the development of higher-order thinking are not lacking. Unfortunately, as Prawat (1991, p. 8) in his review of the research literature notes, "few studies to date have attempted to compare the relative effectiveness of different ways of promoting higher-order thinking in students."

We are currently in the process of conducting a study which uses each of the three approaches previously described to teach self-regulated learning strategies. The intent of the design has been to determine which approach (the stand alone, embedding, or immersion) best facilitates the development of higher-order, specifically self-regulating, thinking skills when employing a videodisc-based instructional system. It is our hunch that the immersion approach, by capitalizing on natural forms of learning when presented within the framework of the cognitive apprenticeship model, may prove the more powerful method of the three. Ultimately, based on the results of this and future studies, we hope to continue this line of inquiry by developing an intelligent tutoring system using interactive videodisc-based instruction designed to teach self-regulated learning strategies to college-age students.

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Appendix A
Dimensions of Self-Regulated Learning
A Working Model

General definition: (A) The ability to monitor, regulate, evaluate, sustain, and strategically modify, when necessary, the learning process and (B) sensitivity to, and ability to exercise control over, motivational and contextual factors that affect learning outcomes. The basic components of self-regulated learning include (1) epistemological beliefs (2) motivational processes (3) metacognitive processes (4) learning strategies (5) contextual sensitivity and (6) environmental control and/or utilization. Self-regulated learners are possessed of a belief system that views knowledge as complex and evolving, rather than simple and fixed, and the knower as capable of self-modification. An individual is a self-regulated learner to the degree that she/he is able to effectively monitor and regulate (control) and sustain the learning process, apply a variety of appropriate and efficient strategies to learning problems encountered, maintain a sense of competence, (intrinsic) motivation and personal agency, accurately diagnose the character and demands of particular learning challenges, and effectively utilize and control environmental factors that have a bearing on learning outcomes.

Six Dimensions of Self-Regulated Learning

A. *Epistemological Beliefs*: Defined as relatively enduring and unconscious beliefs about the nature of knowledge and the process of knowing.

B. *Motivation*: Refers to goal-oriented effort that is a complex function of goal value, goal accessibility, perceived likelihood of success and one's sense of self-efficacy.

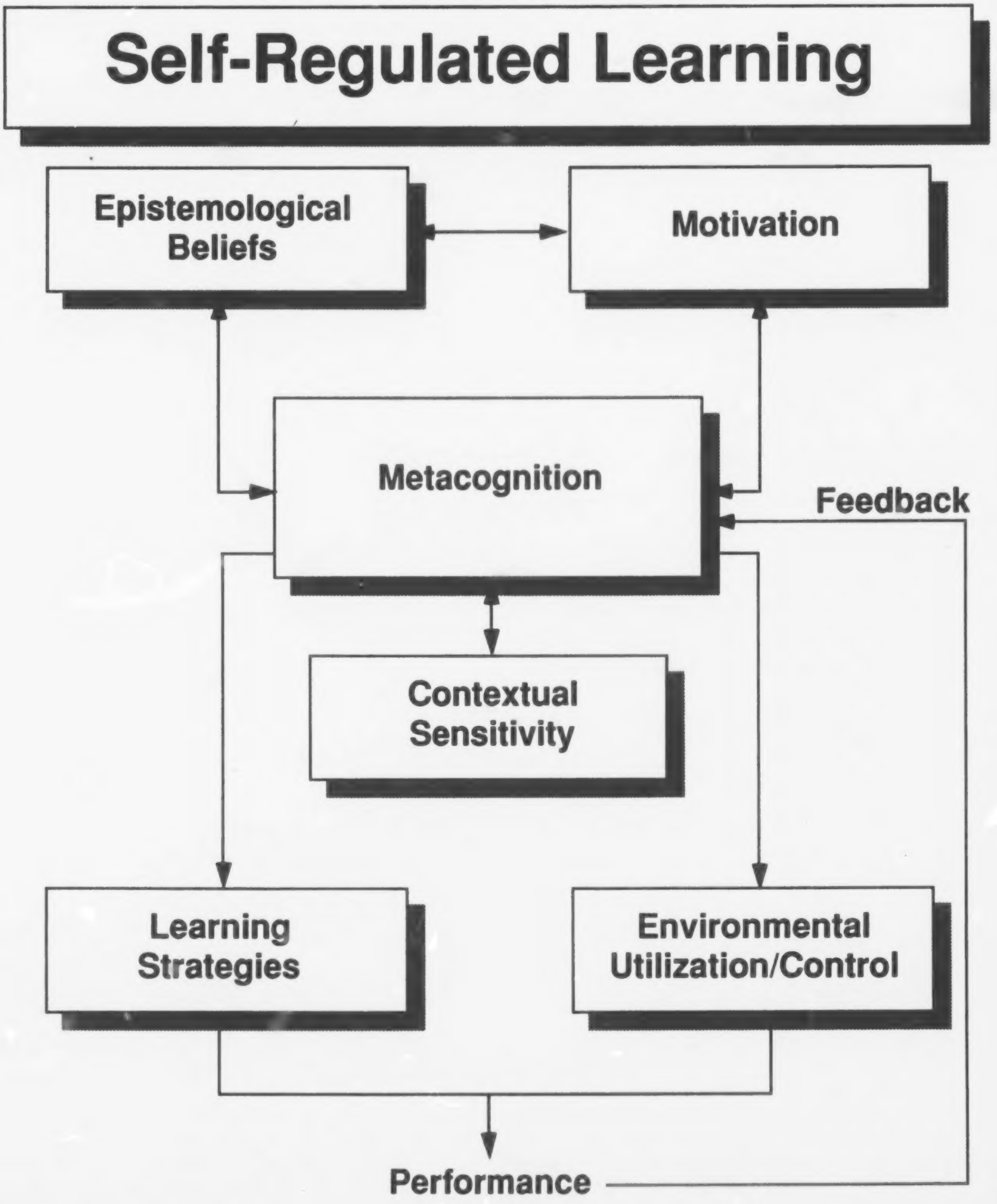
C. *Metacognition*: Defined generally as (1) knowledge about cognition and (2) awareness and conscious regulation of one's thinking and learning. The executive engine of cognition.

D. *Learning Strategies*: Refers to both operative knowledge of specific learning tactics (highlighting, summarizing, etc.) and the ability to combine various tactics into an effective learning plan.

E. *Contextual Sensitivity*: Refers to the ability to "read" the learning context for what it specifies regarding the demands of a particular problem setting and what it affords in the way of problem resolution.

F. *Environmental Utilization / Control*: Refers to the utilization and management of circumstances and resources external to the self in the pursuit of learning-related goals.

Appendix A (Continued)
Graphical Representation of the Working Model


Self-Regulated Learning
Epistemological Beliefs
Motivation
Metacognition
Feedback
Contextual Sensitivity
Learning Strategies
Environmental Utilization/Control
Performance

Appendix B: Subscales of the Self-Regulated Learning Inventory with Sample Items

Sample Copy

SELF-REGULATED LEARNING INVENTORY 9/17/92

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Circle One

CLASS: F S Jr Sr Gr Other________________
SEX: M F
ETHNICITY: EA AA HA ASA NA Other________________
HIGH SCHOOL: U S R

GPA (on 4.0 scale): ________________
AGE: ________________
TEL (last 4 digits): ________________

INSTRUCTIONS: Please read each statement and then circle a response according to the following key:
a = Almost always typical of me
b = Frequently typical of me
c = Somewhat typical of me
d = Not very typical of me
e = Not at all typical of me

Respond as candidly and completely as possible by selecting the response most descriptive of your usual approach, and/or attitude, toward academic coursework. Try to rate yourself according to how well the statement describes you, not in terms of how you think you should be or what others think of you. There are no right or wrong answers. Your responses will be kept strictly confidential and are for research purposes only. Please complete all the items.

Not at all typical of me
Not very typical of me
Somewhat typical of me
Frequently typical of me
Almost always typical of me

Sample Metacognitive Items

1. After reading new information for a class, I mentally review it to get a sense of how much I have remembered. a b c d e

2. When studying, I make a mental note of concepts, terms or ideas I don't fully understand. a b c d e

Sample Learning Strategy Items

3. A study strategy I use to memorize a list of several things is to recite and rehearse the items until I can recall them from memory. a b c d e

4. When I have to learn unfamiliar concepts or ideas which are related, I use mental images to help tie them together. a b c d e

Sample Motivational Items

5. Mastery of new knowledge or skills is more important to me than how well I do compared to others. a b c d e

6. I find that if I don't expect to do well in a course, I become less motivated. a b c d e

Not at all typical of me
Not very typical of me
Somewhat typical of me
Frequently typical of me
Almost always typical of me

Sample Contextual Sensitivity Items

7. No matter what kind of exam I am preparing for, I always use the same study techniques. a b c d e

8. I adapt the study strategies I use based on the type and demands of a particular course. a b c d e

Sample Environmental Control Items

9. If I do not understand the material presented either in the text or lecture, I try to get help from someone who does. a b c d e

10. When studying, I isolate myself from anything that might distract me. a b c d e

Sample Epistemological Beliefs Items

11. Really smart students don't have to work hard to do well in school. SA A U D SD

12. If a person tries too hard to understand a problem, they will most likely just end up being confused. SA A U D SD

Title:

Reading Preferences of American Indian and Anglo Children for Ethnicity, Gender, and Story Setting

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662

Abstract

This study investigated the reading preferences of American Indian and Anglo children with respect to ethnicity of main character, gender of main character, and setting in children's stories. The 160 subjects consisted of 80 American Indians and 80 Anglos from Grades 2 and 3, divided evenly by gender and grade level. The study yielded significant preference differences for ethnicity of main characters, gender of characters, and type of setting Both Indian children and Anglo children preferred to read about Indian characters over Anglo characters. A majority of all the subjects indicated a preference to read stories with both an American Indian and an Anglo as main characters, rather than stories with two Indians or two Anglos as main characters. Males preferred to read stories with at least one male character over stories with only females; whereas, girls preferred to read about two boys instead of a boy and a girl. Both Indian and Anglo subjects preferred stories set in a suburban-type setting over reservation-like settings.

Introduction

Educational reform is of prime concern and interest to educators as well as the general public. This concern is understandable when 13% of all 17-year-olds, and 40% of all minority youth can be considered functionally illiterate, (National Commission on Excellence in Education, 1983). The concern still exists for students who proceed on to attend college. Approximately 25% of the Hispanic and American Indian students attending one of the nation's largest universities report that they did not feel adequately prepared for their coursework, (Morrison Institute, 1990). These problems and others are being addressed by different educational reform measures. One focus of the reform measures is to decrease illiteracy by improving reading achievement in the primary grades.

One way of improving reading achievement is to provide students with interesting material. Cecil's (1984) study revealed that interest in reading material has a positive relationship to comprehension of the content. Research also indicates that intrinsic motivation to read increases when children are exposed to materials that reflect their reading preferences (Busch, 1972). Clearly, authors and publishers should use children's preferences as an important basis when designing stories and other educational materials for children (Harper-Marinick, Sullivan, and Igoe, 1990; Summers and Lukasevich, 1983).

This study investigated children's preferences related to three variables in stories: ethnicity of the main characters, gender of the main characters, and setting of story. These variables are particularly relevant to current concerns about multiculturalism and equity in our society.

Children's preference for ethnicity of the main character is a component of reading material that has been neglected. Studies have shown that primary grade children exhibit a preference for their own ethnicity when making friendship choices (Braha & Rutter, 1980; Davey & Mullin, 1982; Denscombe, 1983). This suggests that children may also prefer to read stories with characters of their own ethnicity. However, the availability of reading material about children of their own ethnicity is limited for many minority children. In a random sample of 203 stories found in 1st, 3rd and 5th grade basal readers, only one story containing an American Indian was found at the first grade level, six at third, and nine at fifth (Reyhner, 1986).

Research on gender of the main character suggests that children in the primary grade children prefer to read stories about characters of their same sex, with boys demonstrating a stronger same-sex preference than girls. Rose, Zimet and Blom (1972) found that first-grade boys preferred stories with male characters and first-grade girls preferred stories with female characters. Research by Harper-Marinick, et al. (1990) revealed that first- and third-grade Anglo, Hispanic, and Black inner-city students strongly preferred both same-sex and combined-sex (a boy and a girl) pair of characters over those of the opposite sex. Beyard-Tyler and Sullivan's (1972) study revealed that among adolescents in grades 7, 9, and 11, boys preferred to read stories with male protagonists and girls preferred to read stories with female protagonists. However, both boys' and girls' preferences for males increased at the highest grade level.

The setting of children's stories has been an area of increased interest in recent years. It is a popular adult belief that inner-city, minority children should be exposed to reading materials that reflect their everyday environment. However, research by Okada and Sullivan (1971) and Harper-Marinick, et al. (1990) indicate that this belief may not be consistent with children's preferences. Findings from their studies indicate that inner-city children prefer stories with a suburban-type setting.

The present research was conducted to study the reading preferences of Anglo and American Indian second and third grade children with respect to ethnicity of main character, gender of main character, and story setting. The study investigated preferences for reading stories with either: 1) Anglo main characters, American Indian main characters or both, 2) male main characters, female main characters, or both, and 3) settings similar to or different from the surroundings in which the subjects live. Preferences were investigated across ethnicity and gender of the students.

Method

Subjects

A total of 160 children, 80 Anglo and 80 American Indians from grades two and three served as subjects. Eighty subjects were male and 80 were female; 81 were in the third grade and 79 in second grade. The Anglo participants came from a predominantly Anglo elementary school located in a Southwest metropolitan area. The American Indian participants came from two elementary schools located on Indian reservations near the same metropolitan area. The socioeconomic status of the students on the reservations is similar to many Southwest minority populations. The income level, unemployment rate, and school dropout rate are such that many of the students on the reservation are generally considered to be "at risk" of academic failure.

Materials

The materials consisted of 18 black and white 8 1/2" X 11" illustrations adapted from previous reading preference studies (Okada & Sullivan, 1971; Harper-Marinick, et al., 1990). The illustrations were organized into three categories: ethnicity of main character, gender of main character, and story-setting. Each category consisted of three pairs of illustrations.

Materials for ethnicity of main character included three pairs of illustrations representing the following combinations of children reading a book at a table: 1) two American Indians, 2) two Anglos, and 3) an Anglo and American Indian. This category was designed for use on a same-sex basis, that is, materials picturing only males were used with male subjects and materials showing only females were used with female subjects. Body positions and physical surroundings were consistent from picture to picture. Ethnicity was depicted by slight changes in physical features, such as skin tone, dress, and length and style of hair. The Indian characteristics in the illustrations were based on recommendations from American Indian artists.

The characters used in the ethnicity illustrations were also used for the gender of main character illustrations. They were arranged to include the following combinations of children reading a book: 1) two boys, 2) two girls, and 3) a boy and a girl. These materials were designed for use on a within-ethnicity basis. Materials picturing only Anglos were used with Anglo children and materials showing only American Indian children were used with American Indian children.

The story-setting materials included three illustrations depicting environmental settings commonly used in children's stories: 1) a school exterior, 2) a home exterior, and 3) a shopping area. These illustrations were drawn from photographs of actual settings. Two illustrations were prepared for each of the settings, one depicting a middle-class metropolitan setting and the other depicting a setting representative of an Indian reservation in the Southwest.

An example pair of illustrations for each of the three variables (ethnicity of main character, gender of main character, and story setting) is shown in Figure 1.

Insert Figure 1 about here

Procedures

Each subject was interviewed individually by one of the two trained experimenters. The subjects were given the following directions:

> "I have a friend who writes stories for children just like you. My friend wants to write a story about these pictures but doesn't know which ones you would most like to read about. Look carefully at

these two pictures and tell me which one you would rather read about." The experimenters pointed to each illustration and described it orally in words that noted the relevant contrast in the pair (e.g., "Which would you rather read about, the two Indian children in this picture, or the two white children in this picture?"). Experimenters accepted either a verbal response or the child pointing to the illustration of his or her choice. Left-to-right positioning was systematically alternated for each pair of pictures to negate the possibility that position preferences would influence the results. Each experimenter ran approximately the same number of male and female subjects from both grade levels and across both ethnic groups.

Each subject was shown nine pairs of illustrations, three for ethnicity of characters, three for gender of characters, and three for setting. For example, for ethnicity the three illustrations portrayed two Anglo children together, two American Indian children together, and one Anglo and one Indian child together. For each pair, the child was asked to select the illustration s/he would prefer to read about. Similar procedures were employed for the three illustrations for gender (two boys, two girls, boy and girl), and the three for setting (three different suburban settings paired with three different reservation-like settings). The experimenters recorded responses on prepared forms.

Data Analysis

The proportion of times that each illustration type (e.g. same ethnicity, both ethnicities, opposite ethnicities) was chosen over the other two was recorded for ethnicity and for gender characters. Three separate chi-square analyses were employed to analyze each contrast (same vs. opposite, same vs. both, and both vs. opposite) by ethnicity and gender of the subjects.

The story setting responses were scored 1 for suburban settings and 0 for reservation-like settings. A score of 3 indicates that the subject chose all three of the suburban settings over the reservation-like settings. Analysis of variance (ANOVA) was used for story setting data to analyze differences among subjects by ethnicity and gender.

Data in all three categories were collapsed across grade levels because the scores of second-graders and third-graders were very similar on each of the three variables and no grade-level interactions were present.

Results

The results are reported below by ethnicity of main character, gender of main character, and story setting.

Ethnicity of Main Character

Table 1 shows the proportion of subjects who chose characters of the same ethnicity, both ethnicities, and the opposite ethnicity in the three pairs of illustrations. It can be seen that both American Indian and Anglo children consistently preferred illustrations with an American Indian and an Anglo over those with two children of their same ethnicity and over those with two children of the opposite ethnicity. American Indians chose both ethnicities over American Indians only in 70% of these pairings, and both over Anglos only in 53% of the pairings. Anglos chose both over Anglos only in 65% of the pairings and both over American Indians only in 66%. Overall, illustrations showing both ethnicities were selected 63% of the time when paired with the other two choices. The opposite ethnicity was selected in 44% of the pairings, and the same ethnicity was chosen in 43% of its pairings.

Insert Table 1 about here

The same vs. opposite ethnicity comparison yielded very different preferences for American Indians and Anglos. American Indians chose the same ethnicity (American Indian) characters in 81% of their pairings with Anglo characters. In contrast, Anglos chose the same ethnicity (Anglo) characters in only 25% of their pairings with American Indian characters. This difference in preference on the same-opposite dimension was highly significant, χ^2 (1, 160) = 20.36, $p < .0001$. Boys' and girls' ethnicity preferences did not differ significantly from one another.

Gender of Main Character

Table 2 presents the proportion of subjects who chose characters of the same gender, characters of both genders, and characters of the opposite gender in three pairings of illustrations. Both American Indian and Anglo children indicated a strong preference for the same gender illustrations over those with the opposite gender. American Indians selected the same gender over the opposite in 97% of the pairings. Anglos chose the same gender over the opposite in 95% of these pairings. American Indian and Anglo subjects chose illustrations showing both genders over those showing either the opposite gender or the same gender. American Indians selected both genders over the opposite in 66% of the pairings and both over the same in 63% of the pairings. Anglos chose both over the opposite in 75% of the pairings and both over the same in 60%. Overall, illustrations depicting the subjects same gender were chosen 67% of the times when paired with the other two choices, both genders were selected in 66% of the pairings, and the opposite-gender in 17% of its pairings.

Insert Table 2 about here

The comparison between both genders vs. the opposite gender yielded very different preferences for the boy and girl subjects. The boys selected both genders in 94% of the pairings with the opposite gender. In contrast, the girl subjects selected both genders in only 46% of the pairings with the opposite gender. There was a highly significant difference in this preference between both genders or the opposite gender, χ^2 (1, 160) = 42.976, $p < .0001$. Similarly, 64% of the boys selected the illustration depicting boys over the one with both genders, but only 14% of the girls selected girls over both genders, (χ^2 (1, N = 160) = 42.133, $p < .0001$). There were no significant differences between the gender preferences of the American Indian and Anglo subjects.

Story Setting

Table 3 shows the mean number of suburban illustrations chosen by ethnicity and gender. The table reveals that the 160 students selected an overall average of 2.46 suburban settings and only .54 reservation-like settings from three possible choices. Anglo children chose an average of 2.56 suburban settings and Indian children chose 2.35 suburban settings. Boys selected 2.49 suburban settings and females selected 2.43. Ninety-four percent (N = 150) of the subjects chose all three of the suburban settings (54%) or two of three suburban settings (40%). Only three subjects (2%) selected all three reservation-like illustrations.

Insert Table 3 about here

A 2 (ethnicity) x 2 (gender) analysis of variance (ANOVA) of the data in Table 3 revealed that the number of suburban settings chosen by Anglos (m = 2.56) was significantly higher that the number chosen by American Indians (m = 2.35), $F(1, 159) = 4.049$, $p < 0.05$. The difference between boys and girls was not statistically significant, nor was the ethnicity by gender interaction.

Discussion

Two characters were depicted in each of the illustrations for ethnicity and gender of main character. The reason for using two characters instead of one is that much of the research on children's preferences make the child select between one variable or the other. The weakness in this method is that it forces a choice between variables when in fact both can be incorporated into a story. This study was designed so the children can make the choice of reading about both ethnicities or both genders.

The findings from this study have positive implications for fostering the concept of ethnic diversity in children. American Indian and Anglo subjects consistently preferred to read about characters from both ethnic groups over those from their own group or from the opposite group. Interestingly, Anglo subjects also showed a strong preference for reading about the opposite ethnic group (American Indians) over their own ethnicity.

The results from three studies investigating friendship choices of primary grade children suggest that children prefer friends of their own ethnicity (Braha & Rutter, 1980; Davey & Mullin, 1982; Denscombe, 1983). However, this trend for same ethnicity friends did not transfer to the subjects preferences for which ethnicity they would most like to read about. The subjects in this study preferred to read about both ethnicities over their same ethnicity.

A very striking difference is present in the subject's responses to reading about characters of their same ethnicity over the opposite ethnicity. Eighty-one percent of the American Indian children preferred to read stories with American Indian main characters. Only 25% of the Anglo subjects chose to read stories with Anglo children. Perhaps the Indian children indicated a preference to read about their own ethnicity because they seldom get to read about themselves and would like to.

Anglo children, on the other hand, nearly always have the opportunity to read about their own ethnic group. Their preference for stories with American Indian children as the main characters would appear to reflect a desire for greater variety. They may feel that stories about Indian children have the potential to be more interesting than stories about children like themselves.

Ninety-six percent of both male subjects and female subjects preferred stories with main characters of their same gender rather than those with two characters of the opposite sex. This strong preference for same-gender over opposite gender characters is consistent with previous research on children's preference for gender of main character (Harper-Marinick, et al., 1990; Beyard-Tyler and Sullivan, 1972; Rose, Zimet & Blom, 1972).

Boys and girls differed significantly when choosing between reading about both a male and female or about two characters of the opposite sex. The majority (94%) of the boys preferred to read about both a boy and a girl instead of reading about two girls. In contrast, less than half (46%) of the female subjects indicated that they would prefer to read about both genders instead of two boys. This difference could possibly be attributed to boys not being interested in reading about girls by themselves. The girls, however, might think that reading a story with two boys would be more adventuresome than a story with both a boy and a girl.

Both the American Indian and Anglo subjects indicated a strong preference for stories with a suburban-type setting over those with a reservation-like setting. Although Anglo subjects had a significantly stronger preference for suburban settings than Indian subjects, this pattern was not a strong one when compared to the consistent preference for the suburban settings among both ethnic groups. Previous studies by Harper-Marinick, et al. (1990) and Okada and Sullivan (1971) have found that Black, Anglo, and Hispanic inner-city children have a strong preference for reading about suburban settings over the inner-city settings in which they live.

Suburban-type settings reflect not only a difference in location from the reservation-like settings, but also in economic level, because the setting and economic level go hand-in-hand. Therefore, children may make their selection on the basis of the appeal of a "nicer" setting rather than the location of the setting, per se, even though the oral directions to them on each item explicitly note the setting.

The results have several implications for authors of children's reading material. They support writing stories that encourage the concept of ethnic diversity by having main characters from different ethnic backgrounds, rather than having a very high proportion of Anglo main characters. This would include a selection of stories with American Indian children as leading characters. Lankford and Riley (1986) note that American Indian children need "culturally relevant" instructional material infused into their educational programs. The present results indicate that Anglo children may also benefit from the availability of reading material that includes American Indian characters.

The findings suggest authors should consider providing educational material that allows children to read stories with characters of their same gender, and also stories that have both a boy and a girl as main characters. These findings on children's preferences for ethnicity and gender of main character fit into the current trend of encouraging multiculturalism and non-sexists behavior in today's educational setting.

Research has shown that a student's intrinsic motivation and literal comprehension increases with the use of interesting reading material. This study has revealed that children are interested in stories with more than one ethnic background represented and both genders represented. It has also shown that children prefer to read stories with suburban-like settings. It would be useful to conduct further investigations to determine if children read more frequently, or show increases in learning when provided with reading material which reflects individual reading preferences. Further research which considers reading preferences for other individual content variables and various combinations of variables may also be useful. For instance, would an Anglo boy who wanted to read about two American Indian boys want to read about two American Indian girls? Would the American Indian children want to read about a suburban school with two Anglo boys? Continued research in children's preferences could prove beneficial to future reading improvement efforts.

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Table 1
Preferences for Ethnicity of Characters

		[a]Preferred Ethnicity and Preference Level		
[b]Ethnicity of Subjects	Pairing of Illustrations	Boy Subjects	Girls Subjects	Totals
American Indian	Same vs. Opposite	Same .85	Same .77	Same .81
	Same vs. Both	Both .70	Both .70	Both .70
	Both vs. Opposite	Both .55	Tie .50	Both .53
Anglo	Same vs. Opposite	Opp. .68	Opp. .83	Opp. .75
	Same vs. Both	Both .63	Both .68	Both .65
	Both vs. Opposite	Both .70	Both .63	Both .66
Totals	Same vs. Opposite	Same .59	Opp. .53	Same .53
	Same vs. Both	Both .66	Both .69	Both .68
	Both vs. Opposite	Both .63	Both .56	Both .59

[a] These columns show the preferred ethnic group for each pair of illustrations and the proportion of subjects choosing that group. For example, American Indian boys chose the illustration depicting their same ethnicity (American Indian) over the one depicting the opposite ethnicity (Anglo) 85% of the time, both ethnicities (Indian-Anglo) the same (Indian) 70% of the time, and the illustration depicting both (Indian-Anglo) over the opposite(Anglo) 55% of the time,

[b] n= 80 (40 boys and 40 girls) per ethnic group.

Table 2

Preferences for Gender of Characters

		[a]Preferred Gender and Preference Level					
[b]Gender of Subjects	Pairing of Illustrations	American Indian		Anglo		Totals	
Boy Subjects	Boys vs. Girls	Boys	.95	Boys	.98	Boys	.96
	Boys vs. Both	Boys	.62	Boys	.65	Boys	.64
	Both vs. Girls	Both	.92	Both	.95	Both	.94
Girl Subjects	Boys vs. Girls	Girls	1.00	Girls	.93	Girls	.96
	Boys vs. Both	Boys	.60	Both	.53	Boys	.54
	Both vs. Girls	Both	.88	Both	.85	Both	.86
Totals	Same vs. Opp.	Same	.97	Same	.95	Same	.96
	Both vs. Same	Both	.63	Both	.60	Both	.61
	Both vs. Opp.	Both	.66	Both	.74	Both	.70

[a] These columns show the preferred gender for each pair of illustrations and the proportion of subjects choosing that gender. For example, American Indian boys chose the illustration depicting their same gender (boys) over the one depicting the opposite gender (girls) 95% of the time, the illustration depicting boys over the one depicting both a boy and a girl 62% of the time, and the illustration depicting both (a boy and a girl) over the one showing the opposite (girl) 92% of the time,

[b] *n*= 80 (40 boys and 40 girls) per ethnic group.

Table 3

Mean Suburban Settings Selected by Ethnic Group and Gender

Ethnic Groups[a]	Gender		
	Boys	Girls	Totals
Anglo	2.63	2.50	2.56
American Indian	2.35	2.35	2.35
Totals	2.49	2.43	2.46

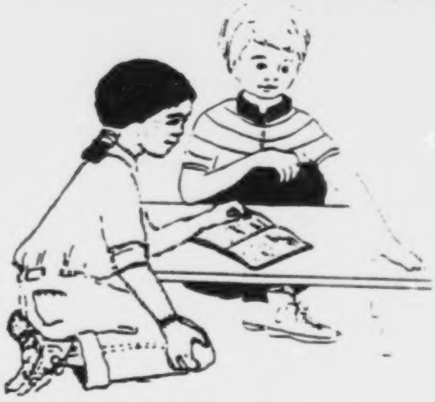
Note. 3.00 = all three suburban settings chosen.

[a] n = 80 (40 boys and 40 girls) per ethnic group.

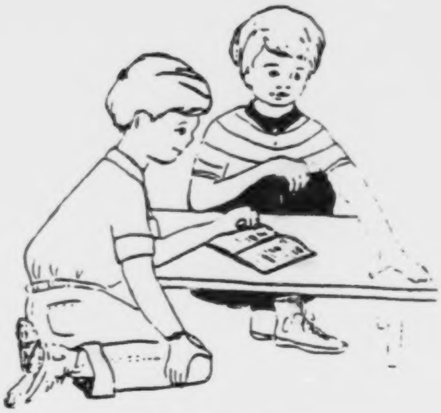
Figure Caption

Figure 1. Sample illustrations for the three variables: Ethnicity of main character, Gender of main character, and Story setting.

Ethnicity of Main Character (male subjects)

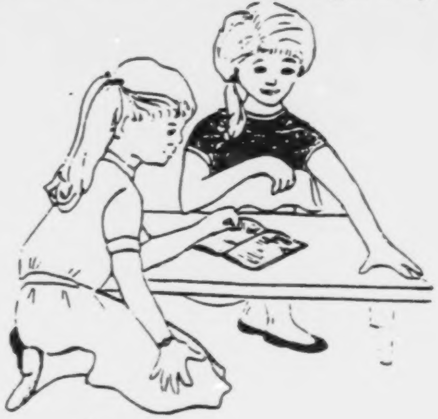


An American Indian and an Anglo

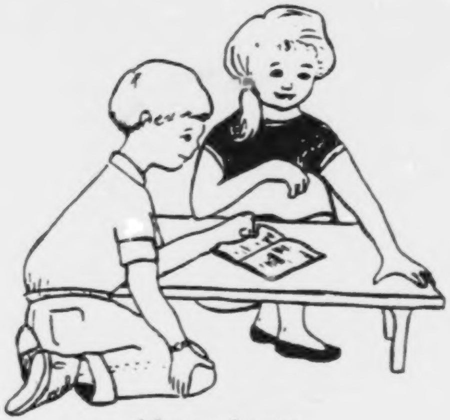


Two Anglos

Gender of Main Character (Anglo subjects)

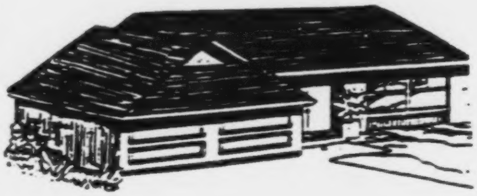


Two girls

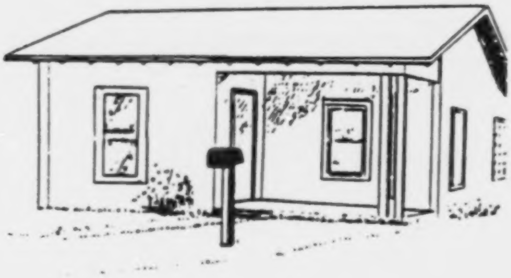


A boy and a girl

Settings



Suburban-like home



Reservation-like home

Title:

The Effect of Interface Types on Learning and Satisfaction for Computer-Assisted Instruction

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ABSTRACT

This study investigated whether the visual forms of buttons influenced learning and satisfaction when early adolescent students were asked to perform tasks using computer-assisted instruction (CAI). Ninety subjects participated. Three visual forms were designed for buttons located in a CAI application. One contained pictures for commands, the second contained words for commands, and the third contained the combination of pictures and words. Each subject was assigned to one of six groups. Each group used two of the three styles of buttons. The groups performed two sets of three tasks. Response time, accuracy, and satisfaction were measured.

The results indicated that groups performed faster with the second task set. The results also indicated that groups were more accurate in their responses when the buttons illustrated words than when the buttons illustrated the combination. Results for satisfaction indicated that groups were more satisfied with the combination than they were with the words.

INTRODUCTION

Students who use CAI will not tolerate a poorly designed interface that is not intuitive at first sight. Since students infrequently use the same CAI application they are less motivated to learn its use. Shneiderman (1987) stated that if the students do not understand the CAI application at first sight the students will likely abandon the use of the computer or try a competing package. Hence, the CAI application's interface must meet their needs. Learning users should be able to point and click with the mouse at commands illustrated on the computer screen. See-and-point interfaces usually contain buttons illustrated as pictures, as words, or as the combination of pictures and words (Apple Computer, Inc, 1987). For adult learners of computer applications it has been found that performance and satisfaction are affected by the visual form in which the commands are illustrated. In fact, studies have found that pictures (Temple, Barker, & Sloane, 1990), and the combination of pictures and words (Egido & Patterson, 1988) are preferred to words by adult learning users.

Research on cognitive development seems to support the notion that pictures and the combinations are preferable for adults when adults are required to understand them as representations of information. According to Bruner et al. (1966), the development of the representations of information in the mind is identifiable during the early stages of life. By adolescence through adulthood the number of mental representations increases depending on experience and maturity and may include visual images and words that denote a single idea. Viewing a picture or the combination of a picture and a word helps adults understand and discriminate ideas that are represented by them.

One of the questions that arises is if early adolescents will perform as well as and be as satisfied as adults when using CAI that includes pictures and the combination of pictures and words for buttons. Do early adolescents have the aptitude to understand picture labels as well as word labels? Finally, does the combination of pictures and words used to illustrate commands on the screen tax the early adolescent's memory load? In order to answer these questions the following study was conducted. The purpose of the study was to determine the effect of the three styles of buttons (pictures, words or the combination of pictures and words) on ease of learning and computer interaction satisfaction when early adolescent school students were required to use a CAI application.

METHOD

Ninety (44 males and 46 females) early adolescent school students participated in the study. Each student was randomly assigned to a group. The groups saw two of the three styles of buttons: picture, words, or the combination of pictures and words. Group A used pictures first and words second, while group B used words first and pictures second. Group C used the combination of pictures and words first and words second, while group D used pictures first and the combination of pictures and words second. Group E used words first and the combination of pictures and words second, while group F used the combination of pictures and words first and words second. The tests were administered during and after school. The study took approximately forty to fifty minutes to complete.

The CAI application contained a collection of facts on history. The students were able to search through subject areas contained in the application easily by pointing and clicking with a mouse on the buttons located at the bottom of the computer screens. The picture labels for the buttons were black and white and the words were displayed in Times Roman at 10 points. The buttons were approximately 1/2" square.

The CAI application was a commercially available package that was modified for experimentation. It originally had picture labels for the buttons. These labels were revised to words and a combination of pictures and words based on the description of the function of the buttons found in a Help section of the CAI application.

Each group performed a set of tasks (i.e., a set of three tasks) while using one of the two styles of buttons assigned. One task at a time appeared on the computer screen when the subjects in the groups selected a button labeled Show Task. After completing the set of tasks, the computer prompted the subjects to complete a satisfaction questionnaire. After completing the questionnaire the subjects viewed the second set of buttons and performed the second set of tasks. After completing the second set of tasks, satisfaction was assessed again.

Each of the tasks required the same amount of mouse motion on the screen and required the same amount of branching through the application. The computer recorded the subject's ID number, the buttons selected, think time which was the elapsed time between button selections, task time which was the total elapsed time on task, and total task time which was the total elapsed time on the set of tasks. The computer process time, which was the computer's time to perform the operation required when a button was selected was recorded independently.

The button selections were identified and a rating of response accuracy was recorded for each set of tasks. The scores could range from 0 to 3 (0 = no correct responses, 3 = all correct responses).

The students had access to each task while searching for the answer. The tasks were displayed on the computer screen when the button labeled Show Task was selected. The time spent reading the task was not included in the subjects' performance scores.

A user interaction satisfaction questionnaire was used to measure satisfaction. Positive satisfaction was indicated by high scores. The questionnaire contained 13 items with 9 point scales. Possible scores ranged from 0 to 117.

DESIGN

The dependent variables response time, response accuracy, and satisfaction were recorded and analyzed in three two-by-two Latin squares with repeated measures designs. The Latin square with repeated measures design was selected because it allowed the researcher to economize on subject numbers and it allowed the researcher to collect data on a number of variables while exposing them to more than one treatment. See Figure 1 for an illustration of the design.

Group	Task Set 1	Task Set 2
A	$X_1O_1O_2O_3$	$X_2O_1O_2O_3$
B	$X_2O_1O_2O_3$	$X_1O_1O_2O_3$
C	$X_3O_1O_2O_3$	$X_1O_1O_2O_3$
D	$X_1O_1O_2O_3$	$X_3O_1O_2O_3$
E	$X_2O_1O_2O_3$	$X_3O_1O_2O_3$
F	$X_3O_1O_2O_3$	$X_2O_1O_2O_3$

Measurements

O_1 = Time
O_2 = Number correct
O_3 = Satisfaction

Treatments

X_1 = Picture Interface Type
X_2 = Word Interface Type
X_3 = Picture and Word Interface Type

Conditions

Task Set 1
Task Set 2

Figure 1. Diagram of experimental design

RESULTS

DESCRIPTION OF THE STUDY

The study was conducted over the course of a month and a half. Initially, the researcher tried conducting the study after school so that there would not be a conflict with the other studies in which the subjects might be involved. However, it was found after several days of testing that many subjects were not willing to participate after school. Some students had other activities to attend, and others lost interest. Due to poor attendance, the researcher tested the remaining subjects during school.

Testing the subjects during school resulted in other problems. The computer laboratory at the school was frequently used by classes. The researcher found that there was little time between classes to collect the data from the computers before another class wanted to use them. In addition, during the time when the computer laboratory was not scheduled for use, teachers and students came to the laboratory to work independently on assigned tasks.

During the testing periods, the procedures were explained to the subjects and the CAI application was demonstrated. When the subjects were told to start, many seemed confused as to what to do. Some asked their peers what they were to do. The researcher helped many subjects get started. After these initial delays, the subjects appeared to have little difficulty in understanding what was expected of them. The researcher accounted for these initial delays during the data analyses.

ANALYSES

Latin square with repeated measures design analyses were performed to determine whether there were significant mean differences in the groups, tasks, and interfaces on the dependent variables: response time, response accuracy, and satisfaction. The groups and tasks were evaluated as independent variables.

Response Time

The results from the analysis of each independent variable for response time indicated that there were significant differences in the two sets of tasks. All groups performed significantly faster when using the second set of tasks. Table 1 and Table 2 display the results.

Table 1.
Analysis of Performance by Task for Response Time

Source	SS	df	MS	Error	F	p
Grps A & B (Task Unit)	171396421.350	1	171396421.350	Error	5.491	<.05
Grps C & D (Task Unit)	369614476.017	1	369614476.017	Error	14.649	<.05
Grps E & F (Task Unit)	247786146.017	1	247786146.017	Error	9.701	<.05

Note: Response time was measured in ticks. There are approximately 60.15 ticks per second in HyperCard (Apple Computer, 1989).

Table 2.
Analysis of Mean Scores by Task for Response Time

	Task Unit 1		Task Unit 2	
Source	M	SD	M	SD
Grps A & B	13175.73	7921.23	9795.43	6002.28
Grps C & D	13508.67	7230.07	8544.70	4056.48
Grps E & F	12235.60	8382.43	8171.23	4573.16

Note: The number of subjects in each group = 15. Response time was measured in ticks.

Response Accuracy

There was a significant mean difference in response accuracy for two of the styles of buttons between groups E (word / picture & word) and F (picture & word / word). Table 3 and Table 4 display the results from the analyses.

Table 3.
Analysis of Performance by Interface for Accuracy of Response

Source	SS	df	MS	Error	F(df)	p
Grps A & B (Interface)	.017	1	.017	Error	.041	n.s.
Grps C & D (Interface)	.017	1	.017	Error	.039	n.s.
Grps E & F (Interface)	3.267	1	3.267	Error	5.834	<.05

Note: Overall ratings for accuracy of response could range from 0 to 3 (0 = no correct responses, 3 = all correct responses).

Table 4.
Analysis of Mean Scores by Interface for Accuracy of Response

	Pictures		Words		Pictures & Words	
Source	M	SD	M	SD	M	SD
Grps A&B	1.30	.85	1.27	.83	–	–
Grps C&D	1.47	.78	–	–	1.43	.68
Grps E &F	–	–	1.50	.90	1.03	.62

Note: The number of subjects in each group = 15. Overall ratings for accuracy of response could range from 0 to 3 (0 = no correct responses, 3 = all correct responses).

Satisfaction

There was a significant mean difference in satisfaction for two of the visual forms between groups E (word / picture & word) and F (picture & word / word). Table 5 and Table 6 display the results from the analyses.

Table 5.
Analysis of Performance by Interface for Interaction Satisfaction

Source	SS	df	MS	Error	F(df)	p
Grps A & B (Interface)	1.067	1	1.067	Error	.015	n.s.
Grps C & D (Interface)	1.667	1	1.667	Error	.061	n.s.
Grps E & F (Interface)	576.60	1	576.60	Error	4.710	<.05

Note: Computer interaction satisfaction scores could range from 0 to 117. Positive computer interaction was indicated by high scores.

Table 6.
Analysis of Mean Scores by Interface for Interaction Satisfaction

	Pictures		Words		Pictures & Words	
Source	M	SD	M	SD	M	SD
Grps A&B	75.83	16.03	76.10	15.03	–	–
Grps C&D	81.30	15.55	–	–	81.63	15.92
Grps E&F	–	–	76.53	17.39	82.73	15.77

Note: The number of subjects in each group = 15. Computer interaction satisfaction scores could range from 0 to 117. Positive computer interaction was indicated by high scores.

DISCUSSION

The styles of buttons used for the commands in see-and-point interfaces can influence a learner's ability to use CAI. The goal is to select the appropriate type. The learner dealing with new information should be able to easily navigate through a CAI lesson. Understanding the most appropriate way to display the commands becomes increasing important as students are required to use technology to learn. Some might argue that the type of button used for a command depends on what concept is being represented. Sometimes it might be easier to use a word to illustrate a command, in other cases it might be easier to use a picture. However, when faced with designing the interface it is important to understand what type of button, in general, works best for a particular group of learners. Thus, the present study provides some tentative conclusions that can help guide learner interface design.

The results from the present study indicated that the early adolescent school students in groups E (word / picture & word) and F (picture & word / word) were more accurate in responding to the computer interface that included words only compared to the interface that included the combination of pictures and words. Perhaps, computer interfaces that incorporate words are easier to identify because words tend to be less ambiguous for early adolescent school students. For example, for a concept such as "print an image to the printer" the word Print might be more explicit. A picture of this concept might be difficult to represent especially in a small space on the computer screen.

Another possibility is that the combination of pictures and words provided too much information compared to words. The computer screen may have appeared overwhelming in a testing situation. The subjects may not have been able to focus on each button in order to infer a meaning from it. According to Galitz (1989), the degree to which a user's memory is being used to understand the information can have a significant impact on their comprehension of the information. If the amount of information is too much the user's performance will be negatively influenced.

It is interesting to note that the groups who used the words and the combination of pictures and words were more satisfied with the combination even though they didn't perform as accurately with the combination. This finding illustrates that user satisfaction is not necessarily a good predictor of user performance. According to Long, Hammond, Barnard, Morton, Clark, (1983), the opinions of users do not predict how well users will perform.

All groups were faster the second time with the second set of tasks. Possibly, as students developed an understanding as to how to navigate through the program the speed with which they performed increased. However, the accuracy in their performance was not affected. It is possible that the subjects felt pressured to finish the second set of tasks quickly but not necessarily more accurately because other subjects had finished. The researcher instructed subjects who were finished to quietly leave the computer laboratory or do another activity. However, it was difficult to keep the students quiet after finishing the tests. The other subjects who were still working were probably distracted by this commotion and felt a need to quickly finish.

An important issue is whether the results obtained in the present study can be generalized. The CAI application used in the present study represented a general layout which is seen in other CAI applications. The buttons appeared in black and white on the bottom portion of the screens. However, the results might be specific because only a small sampling of representations for commands were evaluated.

"Which style button should CAI use?" This question remains unanswered. However, the present study provides some tentative conclusions to guide learner interface design. The study found differences between the words and the combination of pictures and words when early adolescents were required to perform search tasks using CAI. In addition, it was found that satisfaction with an interface does not necessarily indicate how well an early adolescent school student will accurately performed search tasks when using CAI. From these findings it appears that there is a difference between words and the combination of pictures and words. However, further research needs to be done in order to substantiate the significance of these findings.

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Title:

Procedures for Assessing Teachers' Computer Use Based on Instructional Transformation

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The Levels of Computer Use assessment (LCU) was developed to classify teachers' use of computers so that variations of use could be studied. It was derived from the model of Instructional Transformation (Rieber & Welliver, 1989; Welliver, 1990). The development of the LCU was stimulated by the identification of the discrepancy between advocacy for the use of computers in education and their actual use by teachers.

It is widely believed that computer technology can help improve the educational system (see The National Task Force on Educational Technology, 1986; United States Office of Technology Assessment [OTA], 1988; Sheingold and Hadley, 1990; Shanker, 1990). At the same time, the availability of computers in schools has increased. In the period from 1983 to 1987, the average pupil-to-computer ratio in public elementary schools improved from 112.4 to 36.8 pupils per computer (OTA).

Despite the positive trends in computer availability, relatively few teachers have integrated computers into teaching. A recent national survey has shown that even in schools where computers were available at more than double the national average, only about one teacher per school had integrated the computer into the classroom (Becker, 1989; Sheingold & Hadley, 1990). Apparently, sheer availability of computers did not result in their increased integration into teaching.

Indeed, there is a strong sentiment of disappointment and disillusionment among teachers regarding educational technology (Becker, 1987; Bjerklie & Hollis, 1991; Dronka, 1985; Ely & Plomp, 1988; O'Neill, 1990; Roblyer, 1988). The poor opinion of educational computing by teachers does not agree with the views of its supporters and patrons in government, academe, and teachers' unions. This discrepancy in perceptions of educational computing deserves study because the result of it is that computers in education are underutilized. As a result, whatever hopes there are for educational computing to affect education may never be realized. For the research on teachers' computer use, a fundamental question is, "What is meant by *use*?" This question has been addressed in the model of Instructional Transformation suggested by Rieber and Welliver (1989).

Instructional Transformation

The model of Instructional Transformation describes the process of the adoption of innovation. This is an area of human behavior that has been studied generally—types of adoption behavior based on length of time have been described (Rogers, 1983; Rogers & Shoemaker, 1971) and specifically—a framework for analyzing the adoption of innovations among educators has been described (Hall, Loucks, Rutherford, & Newlove, 1975). The model of Instructional Transformation focuses on the adoption of a specific educational innovation—the computer—and describes a teacher's progression through five stages of involvement with computers (Rieber and Welliver, 1989; Welliver, 1990). First, a teacher becomes familiar with computers (*familiarization*); then, the teacher uses computers in teaching (*utilization*). A higher level of use is observed when the computers have become critical to the teaching (*integration*). An analogy to this scenario would be of one who upon learning to drive (*familiarization*), uses the car to improve one's general transportation in order to fulfill a variety of purposes (*utilization*). One may then schedule the use of the car so that the vehicle is critical to the function of fulfilling the purposes (*integration*). In education, this stage includes the teacher's awareness of the change of his or her role. With this new awareness of the restructuring of teaching activities, the teacher pursues an expansion and fine tuning of the computer-teacher-student relationship (*reorientation*). The final stage (*evolution*) is more of a suggestion than a condition, and that is to continue practicing and learning about how to develop the improvement of instruction through the systematic implementation of computer technology.

The definition of *use* for the Levels of Computer Use assessment was derived from the model of Instructional Transformation. Use was defined as the integrated employment of computers in teaching. Two levels of use were designated—Utilization and Integration. At the Utilization level, a teacher shares and delegates teaching duties to the computer; however, the absence of the computer would not prevent the implementation of instruction. At the Integration level, teaching duties would also be shared by and delegated to the computer; however, the absence of computers would prevent the implementation of instruction. The distinction between the Utilization and Integration levels lies in the expendability of the computer technology. Expendability describes the relationship of computer technology to a teacher's planned instruction—whether or not instruction would be able to continue in the hypothetical event of, say the sudden absence of computer technology. It is this dimension of expendability that was identified as the cut-off for membership in either category. According to the model of Instructional Transformation, the Integration stage is further characterized by the dimension of a teacher's emergent self-awareness of a role change in teaching from teacher-centered to learner-centered. In a departure from the model, the assessment does not encompass the dimension of awareness of role change.

Development of the Assessment

The LCU is the result of several attempts at varying formats. In the original conception of the assessment, items were written for each of the five stages of the model of Instructional Transformation. This had been field tested and revised several times and was finally supplanted by the current format. The earlier forms of the assessment adhered to the progressive nature of the model and attempted to capture all of its dimensions, however, it was difficult to classify responses. This is because there are several dimensions that run throughout the model in a progressive overlapping manner. In the current form, one dimension is assessed. The most appropriate technique for this sort of assessment is the paired comparisons technique. This technique requires that a discrete definition be operationalized to determine the cut off for the levels of use. Additionally, the levels need to be mutually exclusive and exhaustive. Nunnally (1959) considers this method "the most exact psychophysical tool..." useful for precise information concerning judgments or preference.

In the format of the LCU, each item from one level is paired alternately with each item from the other level (See Table 1). For example, if there were four items, two from the first level (1a, 1b) and two from the second level (2a, 2b), the paired comparisons would be (1a/2a), (1a/2b), (1b/2a), and (1b/2b). The respondent is forced to endorse one item per pair. The paired comparisons technique allows only one combination of responses to indicate membership at either level. There are four pairs of items in this version. Two items indicate the Utilization level and two the Integration level. If, for example, a value of 1 were assigned to responses indicating the Utilization level, consistent responses for 4 items would score 4 points. A value of 2 for responses indicating the Integration level, would result in consistent response scoring of 8. Acceptable scores would be 4 or 8. Scores of 6 or 7 indicate an inconsistency. The four items were selected from a field testing with a sample of 50 elementary school teachers because those items had the highest response consistency. In that testing, there were 15 items. Items which generated response inconsistency or which introduced an additional dimension were eliminated.

In a subsequent field testing, twenty-three elementary school teachers responded; there were 2 inconsistent responses. The estimated reliability of the LCU for the second field trial using the Coefficient of Reproducibility (*CR*) was .74. One of the items was reworded. The LCU was then administered to 170 elementary school teachers. The *CR* was estimated at .96. A *CR* of .90 is the criterion for demonstrating that items form an ordered scale of allowable response patterns (Crocker & Algina, 1986). The teachers were also asked to respond to a control item about their self-reported computer use; the responses were matched with those of the LCU and provided additional data for estimating criterion-related validity. The consistency of classification of the measure was estimated computing Cohen's kappa (*Kappa* = .72). The results are important for two reasons: 1) the estimated reliability is high, and 2) the demonstration of an ordered scale suggests that the model of Instructional Transformation identifies at least two progressive levels.

Table 1
The Levels of Computer Use assessment

1. *a. In my instruction, the use of the microcomputer is supplemental.
•b. The microcomputer is critical to the functioning of my instruction.
2. *a. The use of the microcomputer is not essential in my instruction.
•b. For my teaching, the use of the microcomputer is indispensable.
3. •a. The microcomputer is critical to the functioning of my instruction.
*b. The use of the microcomputer is not essential in my instruction.
4. •a. For my teaching, the use of the microcomputer is indispensable.
*b. In my instruction, the use of the microcomputer is supplemental.

Note: • indicates an item of the integration level.
* indicates an item of the utilization level.

The LCU has been used in several studies. It has been used to establish a dependent variable—level of computer use—in a study of elementary school teachers (Marcinkiewicz, 1991, in press) and in a longitudinal study of preservice undergraduate teachers (Marcinkiewicz & Grabowski, 1991). It has been adapted by the Grosse Pointe (Michigan) Public School System for use in its Staff Computer Skills Survey (J. Corbett, personal communication, February 21, 1992). It is being used to establish a dependent variable—levels of computer use—relative to the subjective norms of rural teachers. It should be noted that prior to this writing, the assessment has been referred to as the LU assessment. As of this discussion, the assessment is referred to as the LCU—Levels of Computer Use—assessment. This modification has been made to reflect the purpose of the assessment more accurately. This modification also underscores the ongoing study of the assessment and of the model of Instructional Transformation.

Discussion

There is a fundamental notion in computer implementation that is often overlooked—not all intended computer users do use them. As with most innovations, people vary in their adoption of computer use. By focusing on a specific profession such as teaching, the study of how its members—teachers—differ in their use of computers is more manageable. They differ before they begin to use computers and they differ once they have begun to use them. Before use, they differ in the time it takes to adopt the idea of using the technology. After teachers adopt the notion of using computers, they differ in the nature of their computer use. The importance of the model of Instructional Transformation is that it addresses the fundamental variance in the adoption of computer use. It describes the progression of a teacher from the onset of the adoption of computers. In application, this theoretical model will help educators in several ways: 1) to identify the range of expected behaviors applicable to a teacher's computer use—what can we expect a teacher to become?; 2) to identify the level of a teacher's computer use; 3) to identify whether a teacher is progressing in computer use; 4) to identify how the nature of a teacher's instruction changes due to his or her computer use; 5) to identify how the nature of teacher's professional self-perception changes due to computer use.

When educators can identify these aspects of teachers, the professional growth and development of teachers relative to computer use can be understood. With this understanding there is a basis for recommending staff development, remediation, or differential staffing. The LCU assessment was developed so that educators could implement the model of Instructional Transformation. Some applications of the assessment include assessing a school's teachers to determine the current computer utilization/underutilization levels before a purchase order for computers is issued, so that the likelihood of future use can be estimated. Also, as a school is designing its restructuring plans, the LCU can be used in needs assessment to identify discrepancies in the levels of computer use. A school may also study the assessment and the model of Instructional Transformation to learn what the extent of possibilities of computer use in education are. In doing so, a school can be helped in clarifying its goals in the application of computer technology.

The LCU accomplishes the classification of teachers into two levels of computer use. When used for this purpose, the assessment addresses point #2 mentioned above. The current form of the LCU is markedly different from earlier versions. The way in which the current and past forms differ needs to be pointed out to highlight the strength of the current version as well as to identify directions for future research. Most importantly, the past and current versions differ in that the former comprised several dimensions—as does the model—attempting to measure all dimensions. This proved to be confounding since the dimensions share characteristics. It was decided that it was not practical or perhaps possible to capture all the dimensions simultaneously. In the LCU assessment, there is one dimension—the expendability of computers—that is measured. This is the central dimension of the model. Measures of the other dimensions need to be developed; such as for the degree of awareness of the changing of one's role as a teacher.

The successful development of the LCU establishes it as a part of the assessment arm of the model of Instructional Transformation. The model is useful in understanding a teacher's theoretical progression in the adoption of computers. The assessment offers a means for applying the theoretical model.

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Title:

The Global Classroom: An International Perspective

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Abstract

What happens when a global classroom, using computer mediated communication (CMC), connects students internationally? This paper reports the experiences of faculty and students at a Turkish university, Anadolu University, who participated in Globaled, a global education computer mediated communication project. This project, initiated at University of New Mexico, included faculty and students at University of Oklahoma, Florida State University, Arizona State University, University of Wyoming and Anadolu University in Turkey.

The paper begins by examining the question of empowerment, the potential of the computer to offer information to people who have traditionally been information poor, by providing them with networked data through the electronic classroom setting. The discussion proceeds to describe how computer-mediated communication can address this question of empowerment. Following the discussion is a case summary of the participation of students at Anadolu University, Turkey, in a pilot project with Globaled during the Spring Semester of 1992.

As a result of participation in the Globaled program, certain issues emerged which should be taken into consideration if future global classroom situations are to be successful. Issues of 1) pedagogy, 2) motivation, 3) access to information, 4) technical difficulties and 5) language need to be addressed. Finally the benefits of a global classroom, as identified by participants, are discussed. Enthusiasm for computer-mediated communication as an inexpensive way to gain access to information, provide opportunities for practicing a foreign language, and to introduce friends across international boundaries were the most frequently cited advantages. In conclusion, important questions must be answered such as what networked information will be made available, for whom and under what conditions, in order for global education to truly provide equal opportunity for all participants.

Computer-mediated communication (CMC) is one example of an interactive technology which allows the user to have access to a wide variety of resources using existing global networks. The use of CMC for delivery of instruction in industrialized countries has been well documented (Phillips, Santoro & Kuehn, 1989), (Phelps, Wells, Ashworth & Hahn, 1991), (Cheng, Lehman & Armstrong, 1991). In examining the issue of equity and computers, Sutton (1991) concluded that considerable research has been conducted on equity issues among white middle-class students, but that much remains to be done in examining equity issues among other populations. Davie and Wells (1991) make a strong case for the empowering attributes of CMC in the electronic classroom setting.

What has received less attention is the degree to which CMC on a global scale empowers those in cross-cultural or cross-national settings. For the first time users in such settings can access worldwide information sources, select materials appropriate to their topics, discuss ideas with colleagues around the globe, encounter new ideas, and make significant contributions in a truly global exchange of thought. This paper explores the implications of such global information exchange using CMC in settings which have traditionally been termed "information poor".

Empowerment

To empower is to give power to those persons who for social, economic or political reasons, did not previously have that power. The movement to provide empowering opportunities developed as a result of the struggle to provide people with equal educational opportunities, so that they could participate and make well informed decisions in the global community. In order to do that, access to information quickly became the key factor. At the same time, telecommunications technology developed to the point that information databases can now provide answers to questions within minutes. Access to such information gives the user a sense of self-confidence in being able to make well-informed decisions.

For too long, empowering tools and information sources have been available primarily to the affluent dominant cultures whose decisions have affected not only themselves but the world at large. This historical trend can be traced to the Middle Ages when the people who had access to written materials determined the distribution of information which was interpreted and later made available to the masses. The Gutenberg revolution changed the way people received information and it was no longer necessary to have information interpreted before it became available to all. With the most recent technological revolution, and the development of computerized information networks, we have moved one step closer to providing truly equal access to information around the world. The availability of such information allows the user of computer networks the satisfaction of being able to communicate with others on a global scale, sharing information, concerns and points of view. These new users are participating as colleagues contributing their own resources, not simply as recipients of information, and they are making their own contributions to network dialog. When people become active participants in decision making, their curiosity and interest in the educational process and in self-improvement begin to grow. As numerous research studies indicate, when given the opportunity students enjoy using technologies such as computers and networks for learning.

Technologies are considered by many to be empowering tools. The access to information provided by computer networks is believed to provide equal opportunity for users who want to participate in decisions of the greater global community. Many feel that the division between wealthy and poor countries, that is the gap between the 'haves' and the 'have-nots', will be lessened by the acquisition of knowledge through networks. These networks can give individuals a new confidence in their ability to read and synthesize information which is so abundantly available in Western countries. For this reason, many developing countries like Turkey have invested heavily in modern technologies of instruction.

Computer-mediated communication

Computer-mediated communication (CMC) is an electronic system using telecommunications for bulletin boards, electronic mail, and computer conferencing. It is computer conferencing, the ability to use the computer for group work independent of time and location, which promises the greatest opportunities for empowerment (Waggoner, 1992). Many educators have expressed the notion that CMC has the potential to emerge as a new educational paradigm, sharing the stage with traditional education and various forms of distance education, but unique in the interactivity it provides independent of time and space (Kaye, 1989). This interactivity promotes collaborative learning in a less restrictive setting than has been thus far possible. Now students in different locations can, asynchronously 24 hours a day, participate in on-line seminars, on-line discussion groups and other collaborative learning activities (Harasim, 1989).

Global classroom networks which use computer-mediated systems encourage international dialog and resource sharing. One of the pioneers in developing the concept of the global classroom is Takeshi Utsumi, President of GLOSAS (Global Systems Analysis and Simulation) who has worked to develop models of the "Global University" and the "Global Lecture Hall" which provide resources allowing less affluent countries to keep up with advances in global research and education (Utsumi, 1990). The global classroom, using the network resources of international research networks like BITNET, EARNET and INTERNET, can provide online discussion opportunities for students around the world. One such global classroom was the Global Education Project (Globaled) designed by Professor Gunawardena at the University of New Mexico in the Spring semester of 1992. Four universities participated in a global computer-mediated classroom on the topic: Theory and Practice of

Distance Education. Three of the universities were in the United States and one was in Turkey.

During the Spring semester of 1992, students from Anadolu University participated in this Globaled classroom, a classroom without walls which had as its focus the discussion of issues related to educational technology and distance education. The participating class at each university submitted a question related to distance education which other students were encouraged to answer, debate, and question. In addition, students were encouraged to respond directly to others and form subgroups if their topics proved particularly interesting. One goal of the exchange was to develop in students the ability to analyze and synthesize information as well as to develop their communicative abilities on an electronic network. In addition, students were encouraged to participate actively in the discussions and not merely be recipients of information.

The Turkish Case

For the second-year students attending Anadolu University in Eskisehir, Turkey who participated in the Global Classroom, communicating via the EARN network to their peers on another continent seemed like an impossible achievement. Many of the students were from Anatolia, and some had grown up in Eskisehir. Their knowledge of American students came primarily from their exposure to American television programs, and they were anxious to learn more about the conditions and way of life of their fellow students. They were eager to practice their English skills and many of them spent hours reading and composing messages.

Besides making new friends and practicing English, students at Anadolu were eager to get information about their course topic which was not available at their university library. Because the cost of an imported textbook may easily be half a month's salary of the average worker, students and even faculty members can not easily purchase foreign text materials. Therefore, most textbooks used at Anadolu are written in Turkish by Turkish professors and many of those are translations from texts published outside Turkey. Where foreign texts are available, they are photocopied and distributed to students whenever possible.

Given this setting, it was with enthusiasm that students approached the task of learning the mechanics of getting online to access the EARN network. The job was not an easy one. The few machines at the university which were connected to EARN and available to students were constantly in use and generally in need of repair. Cookie crumbs, sesame seeds and cigarette ashes which fell into the keyboard caused keys to malfunction. The repair procedure employed by the computer center security guard was to turn the keyboard upside down and beat it into working. In addition, the university ran out of coal in January and in the computer laboratory, an unheated cement building, the fingers of even the most enthusiastic students would quickly turn cold. Add to that the intermittent electrical failures, keyboards with sticking letters, the temperature in the room, and the difficulty of access, it was remarkable that students remained enthusiastic about the process.

After learning how to use the EARN network and being given the topic for discussion of that week, the students in Turkey would discuss the issues among themselves. Because the semester at Anadolu started almost two months into the semester in the United States, the Turkish students were at a double disadvantage. Their language skills were not at the level of the university students in the United States, and they came into the computer conference when the conference was one-third over. Nevertheless they were fascinated with what the technology could do for them and they immediately asked for library articles and other resources which, they recognized, the other students had available to them. Students at Anadolu took part in the conference for a period of 6 weeks. They did not participate fully due to time of entry into the discussion, lack of fluency in English, lack of adequate resource materials for discussion, and inadequate facilities.

Results

The experience at Anadolu University indicates that there are a number of issues which need to be addressed when the electronic classroom cuts across international borders. These have been grouped into 5 areas.

First, issues of pedagogy must be discussed in advance to be certain that educational assumptions are mutually agreeable. In many countries, the prospect of electronic communication is viewed as a one-way link to the outside world in which questions and requests flow in one direction and materials and resources flow in the other. In addition, many countries rely on rote learning as their primary pedagogical principle. Divergent thinking, analysis, problem solving and group discussion have not been desireable in such educational programs. If the expectations of one group participating in the global classroom are not similar to the expectations of the other, the project will experience some difficulty.

Motivation is a second area which needs to be examined to determine differences between students in various cultures. Both intrinsic and external motivating factors are very diverse in the international community. A student in one setting may have selected a course of study where another student may have been required to take it.

Access to facilities which provide information is not normally available to the general student body in many countries as it is in North America.

Information, especially when provided by electronic means, is frequently viewed as the domain of the faculty, particularly the science and engineering faculty. This attitude, that the use of technology is reserved for elite faculty members in the divisions of science and mathematics, must be challenged if students are to have access to information for making well informed decisions.

Technical difficulties such as frequent power outages, broken down equipment, lack of technical support and a large percentage of downtime often plague those students who most need to be encouraged to use the technology. As a result of these technical problems, students in such situations fall farther and farther behind their international colleagues during the semester.

Finally, the issue of language is one which must be considered in any international classroom. Although students in many international universities read and write English, the amount of written material which is sent electronically, coupled with the particular jargon of the field can cost the foreign student many hours of deciphering. Without the 'face-to-face' signals of a questioning expression or a vacant look, the communicator has little idea that his or her message should be made shorter and more concise. Most important ideas can be communicated in the space of one screen. Part of the international experience, when working with people whose English is a second language, is to simplify language and concepts so that the international student can participate in the exchange of information rather than merely be a recipient of information.

Conclusion

In spite of the many drawbacks which students at Anadolu University encountered in this experiment participating in a global classroom, students who joined the project expressed their enthusiasm for computer-mediated communication as a way to practice their English, get information, draw informed conclusions about topics discussed, develop confidence in their ability to communicate with others, make friends around the world, and promote world peace. In short, they felt empowered with new skills and abilities to access information and participate in a meaningful exchange of ideas on a global scale.

As INTERNET links join more global classroom projects together, students and faculty will find themselves involved in meaningful exchanges of information with colleagues around the world. Library resources which are so limited and costly will soon be available online and via fax to remote locations around the world. As we begin to answer the question of how to provide equal access to information, we must look ahead at what kind of information will be shared. Will it continue to be information by, from and for the dominant cultures? Or will computer-mediated communication truly empower those in developing countries to become full participants in the decision making process of the global community? Therein lies the challenge that faces implementation of the new telecommunication technologies, in order to help people achieve their full intellectual potential.

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Title:

Computers Extending the Learning Environment: Connecting Home and School

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702

Abstract

Qualitative data were collected from 28 homes and 19 classrooms at four schools participating in the Buddy System Project. Buddy loans each student and teacher in selected elementary classes a networked home computer, and provides the schools with additional classroom computers. In this paper we examine three themes from the cross case analysis: the impact on the schools' learning environments; the impact and use of the telecommunications functions; and the home computers' impact on the home environment.

Buddy was considered a success in all of the schools. The computers were enthusiastically received and were used extensively. There was high use of tool-based software that permitted the students to generate and process information, and a minimum use of the computer for rewarding behavior or for rote instruction. The teachers noted that the project had a renewal effect on their careers and a positive impact on the culture of the classroom. Teachers also reported that the majority of their current class computer activities were only possible because there were computers at school and at home. The home computers allowed the students to practice and explore at their own pace and permitted teachers to assign more involved projects.

The Buddy home computers have contributed to general dissemination of computer knowledge. Students entering the program are increasingly familiar with the Buddy computers and software through friends and siblings. Parent noted that their child and the home computer helped them feel more comfortable with computer technology and terminology.

Teachers and parents reported that the written format of the electronic communications functions has had a positive influence on the students' reading, writing, and typing proficiency. Students often preferred spending time on BuddyNet or Prodigy to watching television. Teachers reported several cases of quiet students who blossomed on e-mail, initiating communication through extensive e-mail messages.

A significant factor in successful implementation is the presence of several innovators; teachers or administrators ready to take chances, work at the cutting edge, and lead the way for the others at the school. In addition, the success of the program would not have been possible without a large amount of extra effort on the part of the teachers. All the teachers reported spending long hours learning about software and trying to "keep up with the students." In all cases the teachers reported that the effort was well worth it.

Computers Extending the Learning Environment: Connecting Home and School.

What gateways to learning open when the homes and classrooms of over 2000 students in 20 selected elementary schools are connected by networked computers and e-mail? This study examines qualitative data collected from 28 homes and 19 classrooms at four Buddy System Project schools to provide answers to that question.

Buddy equalizes access to technology by loaning each student and teacher in selected Indiana elementary classes a home computer, modem and printer. It also provides the schools with approximately one computer for every four students in the classrooms. In addition, it seeks to expand the time and space of the learning environment by linking all the homes and schools through electronic mail, computer bulletin boards and a "chat channel," and providing participants access to a commercial informational network such as *Prodigy* or *US VideoTel*.

In this paper we will examine three themes from the cross case analysis: Buddy's impact on the schools' learning environments; the impact and use of telecommunications functions; and Buddy's impact on the family learning environment. These sections are preceded by an overview of the Buddy System Project, an abbreviated literature review, and a methodology section.

The Buddy System Project

The idea for the project arose in 1987 when members from the private sector working with the Indiana Corporation for Science & Technology, met with H. Dean Evans, Indiana Superintendent of Public Instruction.

> Addressing such issues as education in the Information Age, changing work force skills, demands on telecommunications infrastructure, and Indiana's competitiveness in a world economy, the group created what has been described as the most innovative educational project in the nation today (The Buddy System Project, 1991, p. 1).

The long-range vision of the project is to extend the learning experience beyond the classroom by placing a networked computer in the home of every fourth- through twelfth-grade student in the state. The project seeks to equalize access to technology for children of all socioeconomic backgrounds.

Integrating a tool-use approach to computers into the curriculum is another of Buddy's goals. The project emphasizes teaching students to use the computer as a tool to construct knowledge. In order to encourage this approach, the project supplies tool software such as word processing and graphics programs and conducts teacher training in constructivist computer uses and learning strategies, in addition to providing technical support. The project's major objectives fall into three categories. These include improving student skills, increasing parental and family involvement in education, and providing foundations for life-long learning.

The program piloted in the fourth grade of five schools in 1988. By the 1991-92 school year, nearly 2,000 fourth-, fifth- and sixth-grade students in 20 schools were participating in the Buddy System Project. While the pilot sites were funded predominantly by the project's grants, additional sites were funded by a cost-sharing plan. The latter plan was based on a commitment of 40% from the school district and 60% from the State of Indiana. Funding for 1991-92 included $1.5 million of state support.

A central office provided technical and instructional design support to the schools. A help line was available to all participants for any technical problems. Teachers received a stipend for their participation and were provided with computer equipment in school and at home. Further instructional support was provided through spring and summer orientation prior to fall implementation, source books, monthly workshops and newsletters, as well as periodic school visits by site coordinators. Training emphasized that teachers were not to teach a separate computer class, but rather to integrate computers into the regular curriculum.

While the central office was designed to provide technical and instructional design support to help schools attain the objectives listed above, the emphasis of the program was on site-based implementation. While the five pilot sites were adopted by either IBM or Apple, successive schools were allowed to select their hardware platform and software applications. Schools have selected IBM, Macintosh, Apple IIGS or Commodore Amiga computers. Software applications selected included various word processing, spreadsheet, graphics, and communications programs as well as a range of computer-based instruction programs (CBI). Each school also determined the configuration of the computers. Some classes pooled all of the school-designated computers and established a lab. Others opted to divide them among the participating classes.

Telecommunications

Each classroom and home in the Buddy System Project has access to a variety of telecommunications functions. These functions are provided by two different services. The first service is BuddyNet, a wide-area network that was used exclusively by Buddy participants and their families. This service used a switched-data network to connect all participating sites. BuddyNet provided a variety of modes of communication including: one-to-one and one-to-many asynchronous delayed-time messages via electronic mail (e-mail) and bulletin boards; and one-to-one or many-to-many synchronous real-time communication via private and general chat channels.

A commercialized information service, either *Prodigy* or *US VideoTel*, was the second function available. These services provided access to educational games and simulations, dictionaries and encyclopedia-like data bases, as well as current news, entertainment, sports, and weather information. *Prodigy* also allowed the user to access a nation-wide network for e-mail and bulletin boards.

Literature Review

Meta-analyses of computer research (Clark, 1983; 1985; Kulik & Kulik, 1987; Roblyer, Castine, & King, 1988) contend that the majority of studies which attribute learning gains to computer-based learning environments are confounded by covarying and uncontrollable factors. There are two primary faults found in most of these studies. The first is that the studies did not sufficiently separate the medium from the instructional method, the design effort invested, and the content. Second, studies did not sufficiently account for novelty effects. One meta-analysis of computer research (Kulik, Bangert, & Williams, 1983) found that studies lasting four weeks or less had almost twice the treatment effect as studies lasting between four and eight weeks, indicating that novelty is a major confounding factor in this research.

There is a need to supplement the outcome measures of standardized tests with observations of the learning process. In this way, instead of determining whether computers influence learning, we gain a better understanding of *how* the computers influence learning. Qualitative research strategies offer a preferable approach to understanding how computers are used. In addition, the researcher needs to be cognizant of how the use of the computer interrelates with the social dynamics of the learning environment. Pedagogically sound classroom computer use depends greatly upon the teaching style employed. Naturalistic, field-based observational techniques provide a useful approach to describing different teaching styles and their relation to various classroom outcomes.

Field-based observational techniques were used in a study conducted to understand the impact of the computer on classroom organization, teacher-student relations, and curriculum (Mehan, 1989; Riel, 1989). In this study, four elementary school teachers were each given one Apple II computer for their classrooms, and their classrooms were observed over the course of a year. The researchers found that the teachers fit their use of the computers into existing temporal and spatial classroom organizational practices. Cooperative student interaction increased, however, when teachers, seeking to maximize time on the computer, had students work in pairs instead of individually. The major conclusion of both articles from this study was that classroom organization and computer use are mutually influential.

Another project, Apple Classrooms of Tomorrow (ACOT) is striving to document how instructional innovations emerge in high computer access environments. ACOT sites have high computer access, readily available technological peripherals such as video discs, and an emphasis on using technology as a tool to construct knowledge. ACOT has emphasized local site design and control of the high access environments. The project did not implement a standardized program of computer use, but encouraged teachers to develop new curricula and teaching methods in order to fully utilize the high computer access in a constructivist manner.

Teachers were provided with considerable technology support, but were not provided with support for effective change in the curricular areas. ACOT evaluators began to realize that teachers were likely to view technology resources as they viewed other instructional materials; as additions to their existing repertoire of curricular activities instead of catalysts of constructive student work.

> We suspected that the omission of a strong curriculum component in the majority of these technology projects could increase such risk. To explore this possibility, we contrasted technology functions in two sites that differed in the extent of their integration of curriculum design with technology planning (Gearhart, Herman, & Whittaker, 1991, p. 4).

Observations indicated that although the tools of experts (in this case word processing applications) were used in the classroom, they were not necessarily employed as experts would have used them. For example, while all the teachers reported that students were more motivated to write using the word processor and were proud of their professional-looking products, not all of the teachers were using the word processor to support the expert's process approach to writing.

Thus, while students were learning to use an expert tool, they were not necessarily learning to write as experts write; i.e., reworking compositions for clarity and using writing as a way of learning.

This study indicates that researchers need to examine more than just the tools that are used in the learning environment. In order to better understand computer use in education, there is a need to explore the ways in which the variables of software, instruction, and student combine. It is not enough to document that teachers and students are using tool applications, researchers needs to understand how these tool applications are used within specific contexts.

Methodology

These qualitative case studies were based on naturalistic inquiry. Underlying axioms of naturalistic inquiry include the beliefs that:

- Realities are multiple, constructed, and holistic.
- Knower and known are interactive, inseparable.
- Only time- and context-bound working hypotheses are possible.
- All entities are in a state of mutual simultaneous shaping, so that it is impossible to distinguish causes from effects.
- Inquiry is value-bound. (Lincoln and Guba, 1985, p.37)

Belief in multiple realities shifts the focus of research from prediction and control to understanding some level of the complexity of the situation. Thus, these realities must be studied holistically and within context. This approach relies on "thick description" (Geertz, 1973). The rationales for this type of approach can be found in contemporary methodological writings on case study such as Donmoyer (1990), Eisner (1991), Geertz (1983), Lincoln and Guba (1985), Merriam (1990), and Stake (1978).

Because of time constraints a typology was established to set boundaries for the study that included:

- Human interface with the technology: What are the typical uses by students, teachers and families?
- Pedagogy: What's the relation between teaching style & computer use?
- Organizational structures: Have hierarchies shifted because of the project?
- Personal efficacy: What are low, average and high ability students accomplishing within this project?

Starting from this typology, the research became a dialectic between foci and emerging themes that the participants identified as important, such as increased learning motivation, parent/teacher communication, and a tool-use approach to instruction. Other points of repeated discussion included the role of the telecommunications functions, the students' increased self-esteem, and changes in the student/teacher relationship. This report was prepared to provide an understanding of three areas:

- Buddy's impact on the school learning environment,
- Impact and use of the telecommunications functions,
- Buddy's impact on the family learning involvement.

Selection of Sites

Constraints of time and money dictated that the study be limited to four of the 20 Buddy schools. Realizing that each of the sites had a unique story to tell, we understood that we could not randomly select four sites that would provide generalizable information. We purposefully selected diverse sites that would provide a range of factors involved in the implementation of Buddy. Areas for diversity included; hardware platform, length of involvement in the project, school size, demographics, and socioeconomic status. The four sites selected were:

- Taft Elementary School[1] -- A rural school with an IBM lab, Taft was one of the original five pilot schools. The school provided a population with a broad range of SES and no racial diversity (100% white). The program included two fourth-grade and two fifth-grade classes.

- Maplewood Elementary School -- A suburban school with an IBM lab, Maplewood was one of the original five pilot schools. The school is a Discovery Magnet Program school with an emphasis on science. The school provided a population with a range of SES and some racial diversity. The program included four fourth-grade and four fifth-grade classes. Maplewood was slated to be one of the first Buddy schools to make the transition to parent buy-in of the home computers.

- Plainview Elementary School -- An urban school with Macintosh computers in each classroom, Plainview was in its second year of Buddy involvement. The program at this school included two mildly mentally handicapped (MiMH) classes, one fourth-grade and one fifth-grade class. The sixth grade was added in 1992-93. The school offered a population with a low to medium range of SES and some racial diversity. This site was also identified by the Buddy office as one of the most innovative schools in its use of computers.

- Linden School -- An urban school with Macintosh computers in each classroom, Linden was in its first year of Buddy involvement. The program included two fourth-grade classes and one LD class. It will expand in successive years to include fifth and sixth grade. The school's population offered racial diversity and consisted of students from predominantly low SES families.

Family Selection. At each site six to eight families were selected for home visits. We selected a range of student characteristics that included academic achievement levels, level and amount of computer use, socioeconomic status, race, and gender.

Calendar of Case Work

Two researchers were assigned to each of the sites. The teams logged between 18 and 21 days at each site. Visits to homes and school, some in tandem, some individual, were spread over three time periods during the 1991-1992 school year: two to three days in late November and early December of 1991; four days in January or February of 1992; and three to four days in March or April of 1992.

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[1] **Anonymity** The name of the site and of all staff, students and families have been changed to protect their privacy. In some cases, non-consequential identifying features were also changed to further protect anonymity.

Methods

- Open-ended interviews with participants.
- Observations of schools, homes and electronic network.
- Review of program-, school- and student-generated documents.

Interviews. The interviewing methods were designed to allow for free-flowing discussion guided by the established foci about computers use, teaching styles, classroom interactions and instruction, and problems encountered. The relationship between home and school was also discussed. Probing questions clarified participants' definitions of terms and provided better understanding of the meaning of responses. Interviews were tape-recorded and then transcribed for analysis.

The student interviews were conducted on a one-to-one basis during the school day and were approximately twenty minutes in length. The purpose of the interviews was to determine the students' perceptions of their own and family use of the computer and network, what was liked best and least about the project, and how school assignments had changed since the introduction of the project.

The teachers' interviews were conducted during free periods and lunch times. These interviews were more extensive than the student interviews and often had to be spread over several days because of their length and the lack of a continuous block of time. There was also an on-going casual dialogue with the teachers throughout our visits. Interview questions sought to explore teachers' perceptions of changes in classroom management styles, their relationships with students, parents, and other teachers as well as the typical and optimum uses of computer and telecommunications functions.

Principals and the site coordinators were initially interviewed for approximately an hour. There were follow-up interviews with some of the site coordinators. Questions focused on perceptions of organizational and pedagogical impact of the computers and the telecommunications functions.

The interviews with families took place in the homes and typically took an hour and a half on the first visit and approximately half an hour on the second visit. The family members were interviewed as a group. In each case, the Buddy student had previously been interviewed individually at school. In these interviews, we attempted to determine the family's use patterns and perceptions of the strengths and weaknesses of the project.

Observations. To gain a better understanding of teaching styles and approaches, we observed teachers instructing both with and without the computers. During the observations of computer activities, we asked the teachers pre- and post-observation questions to determine their perception of the lessons' objectives, why they had selected the computer for the particular task, and how successful they felt the lesson had been.

BuddyNet was observed to determine the content and continuity of the teachers' homework postings. Between January and May of 1992, the announcements on the electronic bulletin boards of the schools were down-loaded on the average of twice a month. In addition, conversations from the main chat channel were observed for ten-minute intervals at random times of day on the average of once a week. Samples of these exchanges were also down-loaded to provide a comparison to what participants reported of network use.

Content Review of Documents. Documents were collected from each site. The collection included the site's implementation plan, a site description and student-generated work. Articles written by newspapers and journals about the schools and about the Buddy System Project, as well as Buddy-generated publications were also collected. These provided background information about the schools and program and offered further means of understanding what was being accomplished with the computer.

Credibility and Analysis. To increase the validity of conclusions, the technique of "triangulation" (Denzin, 1978) was employed. Triangulation requires data be substantiated from at least three different perspectives before it is submitted for conclusion. There are four different ways to triangulate data: use of multiple and different sources, methods, investigators, and theories. This study utilized three of the four ways. Two investigators were assigned to each site, multiple data sources were used, and data were collected through a number of methods including observations, interviews and document reviews.

To construct the cases, the collected data were organized as a function of preparing to write. Triangulation and participant review were used to correct errors of fact and to gain general confirmation of what was written. Review comments did not guarantee revision, but consideration was given to how the suggestions could help provide more complete, accurate and balanced reports.

The School Learning Environment

Computers often receive lukewarm receptions from teachers. They are unsure of how to use the computer, in both a practical sense as well as a pedagogical sense. The extensive availability of computers and the training that Buddy provided were identified by teachers as two factors that produced a noticeable increase in the level of computer use in their classrooms. Though comfortable with the technology, few teachers in our study articulated a "special" philosophy of computers in education. The majority saw computers as another tool in their pre-existing toolbox. There were no cases of changed curriculum due to the addition of computers. Some teachers noted that they were able to go into more depth on the subjects, but felt that they did not cover any additional material outside of computer literacy. While the technology did not revolutionize their approach, it did cause the teachers to think about their teaching approach.

Computer Configuration

There were three significantly different configurations of the computers throughout the four schools. At Plainview, the students sat at tables arranged in a U and the computers were spaced evenly around the tables. Thus, the computers were always available for use. Furthermore, by their placement among the students, the computers were positioned to be used in cooperative work groups.

At Linden, the computers were lined up along the wall of the classrooms. They were positioned so that only one student (two in a tight squeeze) could sit at the computer. Thus, while the computers were in the classroom and available, the class had to be disrupted to go to the computers. The limited space meant they had to use a rotation system. This individualized approach reduced the time the students could work on the computer and limited the types of projects in which they engaged.

The other two schools placed their computers in a separate computer laboratory. This severely limited access to computers, although it did permit each student to work at his or her own computer.

Amount of Use

The school's choice of a separate computer lab, or in-class mini-labs was related to the amount of integrated use. Teachers with mini-lab configurations were more likely to use the computers throughout the day. Use of the computers at the lab schools was restricted to the time assigned in the computer laboratory and as a result, use was far less frequent. Those with labs viewed computer time as separate from class time and were more likely to emphasize individual work on the computer. Indeed, we found the use of the computers to be separate from the remainder of the academic activity in that the use of the computers was not discussed until the students were lining up to go the lab. While a configuration might reveal a pre-existing philosophy, it also perpetuated particular uses. Teachers were confined to certain approaches given the physical constraints of computer access.

Extending schoolwork. The teachers emphasized the need for both school computers and home computers to facilitate the most successful use of the computer. Without the home computers the students would not have had sufficient time or access to complete projects or to practice drill assignments. As one teacher noted:

> So much more can get done at home where the kids are more relaxed. That's the best thing about having them at home for me, and for them too. They can practices what they need without being interrupted or judged.

On the other hand, students were unable to progress as quickly on their home computer when they were not introduced to concepts and software at school. According to the teachers, the combination of access was especially crucial to the students' progress in touch typing and editing functions. These were viewed as important because typing facility affected the students' composition writing.

Level of Proficiency

The students at all four schools possessed a basic proficiency with the computer. By all observations and interviews, these students could easily turn the computer on, load software, and open and use the basic operations of the available software. Students at Linden, a first year Buddy school, were the least proficient. They were still, however, able to open programs, use the word processor and graphics programs, and (for the most part) create basic HyperCard stacks.

Type of Use

The nature of the use of the computers is central to understanding their effectiveness. The goal of the Buddy System Project is for computers to be viewed as tools to aid learning in the content areas. Ideally, tool use will permit the students and teachers to engage in activities that would not be possible without the computers and that will give the students new and richer insights into the content areas. The schools varied in the degree to which this was accomplished.

We identify four general ways in which computers may be used in the school learning environment, including tool use, to practice content or skills, for computer literacy, and as a reward for good behavior. We use these classifications to guide our discussion of the uses in the schools, beginning with the tool use that best reflects the Buddy philosophy.

As a tool to develop and present information. It is this use of computers that is central to the Buddy philosophy. The computers are integrated into the instruction and serve as a tool for working in the instructional domain.

The teachers at all four schools promoted the tool use of the computers. The teachers emphasized that the computer not be viewed as being for games but rather for work. Most often, the "work" involved a substantial project: a History Day presentation; a submission to an essay competition; a proposal for a space station. The teachers noted that it was only because of the ready availability of the computers both at home and at school that they could do these larger tasks.

This philosophy was perhaps most fully realized at Plainview. Except for the typing program, the use of the computer was predominantly used for tool based software: HyperCard, graphics programs, and Microsoft Works which contains word processing, data base and spreadsheet applications. HyperCard was used extensively to create presentations in science and social studies. However, this was not just a substitute for paper and pencil work. Rather, these teachers saw the presentations as forcing the students to give greater consideration to the audience and to the use of original rather than secondary sources. The computer permitted them to prepare richer presentations by incorporating original sources such as video or audio clips. For example, one student writing about the first African-American teacher in Plainview sent an audio tape and some questions to that teacher who now resides in California. The teacher provided the answers on tape and those answers were digitized and included in the HyperCard stack. The science teacher at Plainview talked about his plans to use public databases that would permit the students to engage in real scientific activities. In these examples and in most other instances of using these software programs, the students were in charge of deciding the topic and designing the product. The teacher served as an advisor to help the student reach his or her goals.

The teachers at Linden were also actively searching for ways to integrate the use of the computer into the curriculum as a tool for learning. They spoke of empowering students. Implementing this instructional philosophy proved difficult. As a step towards a richer learning environment, the teachers required the students to develop HyperCard stacks on science as a substitute for their science tests. While we see this as a positive direction, the teachers did not fully realize their goal of a "richer" learning environment. Rather than giving the students freedom in design, and serving as advisors, the teachers maintained considerable control over the design and content of the stack. The number of cards and the content of each was pre-specified. In another project, the HyperCard stack had to be produced on paper and submitted to the teacher for approval before being typed into the computer. As a consequence, the assignments degenerated into worksheet type exercises. It was more fun for the students and it engaged them longer, but it was a worksheet nonetheless. As the site coordinator at this school noted, there is a need to help "teachers change attitudes about how information is learned and how to impart information." They need to move away from the old paradigm of information transmission by an expert teacher.

At Taft and Maplewood the teachers talked about the computer permitting them to work on large projects; projects that would not be possible without a computer. As one teacher noted:

> Most of the time what we do on the computer has many steps to it. There's a purpose for every one of them, there's a sequence to it, and there's a goal at the end. You wouldn't be able to do that if you didn't have a computer. It would be too time consuming, too frustrating.

As an example of this type of activity, she noted that they were preparing a proposal for the creation of a space station using the word processor and graphic program. The proposal, when completed, would be about forty typed pages.

Provide practice in a content or skill domain. Here we are referencing the use of educational games as well as drill and practice programs. This includes drilling the student in typing, math, spelling, and grammar. It also includes educational games such as "Where in the World is Carmen San Diego?" where students practice problem-solving skills and information-seeking skills.

At Taft and Maplewood, the students regularly worked with spelling, arithmetic, grammar, and typing programs. Based on our observations, it would seem that 40% of the computer time was spent on these activities. At Linden, drill and practice software was used less frequently, but the tool applications were often utilized in a drill and practice manner. For example, the word processor was used to type in the weekly list of vocabulary words and then erase them as a means of practicing typing and vocabulary words at the same time. In contrast, Plainview used little drill and practice programs in the regular classrooms except for the use of a touch typing program and a math "game."

Drill and practice are frequently used with the special education students at both Plainview and Linden. The repetitive nature and the immediate feedback offered by these programs is viewed as especially appropriate for the limited attention span of these students.

Computer literacy. A focus on computer literacy is geared to having the students learn about computers. This entails teaching what a computer can be made to do separate from other instruction instead of using the computer as a tool for working within a content domain. In general, we found a tendency to focus on computer literacy as a goal when the teachers were struggling to integrate the use of the computers into instruction. For example, when having students create databases using a spreadsheet or database program, there was typically little concern with the content, the goal was to give the students experience with the mechanics of the software We think that instruction would be more meaningful to the students and more efficient instructively if the use of the database involved helping the students ask more meaningful questions within the content areas they were studying.

All four schools needed to provide a computer literacy orientation to their incoming fourth graders. For the most part, the entire fourth-grade year is a time when the students learn to use the tools, and by fifth grade the students are able to use them more as tools for work. Several of the schools offer summer programs before the fourth-grade year to teach basic computer literacy.

In the schools that have been implementing Buddy for several year now, it is becoming clear that the basic computer literacy is disseminating to students even before they reach the fourth grade. As many as half of the incoming fourth-grade students at these schools are literate because of their exposure to neighbors' and siblings' Buddy computers.

To reinforce good behavior. When classroom access to computers is severely limited, teachers frequently offer use of them as a reward for good behavior. This approach undermines the potential of the computer as a tool for learning. We were pleased to see little use of the computer in this way among our schools. One exception was in a Linden class where if students did computer homework they were excused from ten minutes of math class so that they could do whatever they wanted on the computer. Students who completed computer homework for the week were given a shareware (computer game) program to take home. Two students in the class whose behavior was unsatisfactory were threatened or faced with the removal of their home computer. While this approach encouraged home use of the computer and had a seemingly positive effect on the behavior of the two students, it presents a dangerous precedent. It creates an attitude that emphasizes computing as a reward, and as something to replace learning other subjects. This approach is contradictory to the integrative tool-use attitude toward computers that Buddy is trying to encourage.

Self-Esteem

An overwhelming response from the teachers at all four sites was that the computers improved the self-esteem of the students. There were two ways in which this happened. First, the products they produced looked better and as a result the students felt greater pride in what they did. Second, the students became experts in the use of the computer. For the most part, they had knowledge that exceeded that of the teachers and family members. Further, they were often called upon to teach adults and other students. This increased self-esteem translated into greater enthusiasm for school.

Equalizing Students

The computers played a particularly important role for those students with learning disabilities and for students who tend to be outliers in the class. As one student at Plainview told us, "Some of the kids that aren't that good in school are good on the computer. It's kind of an extra talent that they have." This is especially true in an environment like Plainview where students are encouraged to discover new functionality and new applications of the programs. Everyone could readily contribute.

On a broader basis, and with much greater implications, the computers seem to provide particular support to students with learning disabilities. Students with attention deficits are able to work for longer periods on the computer. Students with limited manual dexterity can now produce papers that look as neat as everyone else's. The program has influence how others view these students and how they view themselves. One teacher noted that their abilities on the computer had "reprogrammed" her expectations of what they were capable of doing. Another teacher noted that the development of computer skills by students in the special needs classes will permit them to be mainstreamed and even excel in the computer classes in middle school.

The impact of the computer technology on the special needs students was one of the greatest success stories that we observed. There were three such classes in our cases: two classrooms at Plainview with students classified as "mildly mentally handicapped" and one classroom at Linden where students were classified as "learning disabled." In all three of these classes the teachers, students, and parents extolled the impact on the students. They were learning more, they were remembering more, and they were getting more practice at life skills like communication (using telecommunications) and problem solving (learning how to use the programs).

Cooperative Learning

The Buddy System Project promotes cooperative learning. In some schools where this was already the instructional model, the computers seemed to enhance cooperation and sharing. Even where this model was not operative, there was a noticeable increase in sharing among students. Teachers at all four schools told us (and we observed) that the students naturally wanted to share and help each other in using the computers. As a teacher at Linden told us, her class had been quite protective of their work and unwilling to share; however, with the computers, they seek to work together and share expertise.

Energizing the Teachers

While the teachers emphasized the enormous amount of extra work required in implementing the Buddy program, almost all also noted that the program energized them and caused them to rethink their curriculum and their approach to teaching. Almost all of the teachers saw new opportunities in learning and saw the students in a new light and this seemed to have an energizing effect. This is expressed most succinctly by a teacher of mildly mentally handicapped students. She reported that during the first year of the program she worked an extra 20 to 40 hours per week on the Buddy program. Yet she reflects on her experience in the most positive of terms:

> Perhaps we in education have unknowingly limited [our] students by prejudging what they can and cannot do. . . With the Buddy system I did not know enough to limit them with my expectations since I truly did not know what to expect. . . In actuality this became a very happy and fun classroom, unlike anything any of us had experienced. . . I don't know who gained more in these experiences, students or teacher.

Culture of the Classroom

Clearly a change of the magnitude of the Buddy System Project may be expected to impact the culture of the classroom by affecting the way the class interacts and the way everyone thinks of learning and teaching. We saw some of these changes in all the schools. In particular, all of the teachers recognized the expertise of the students and began to rely on this expertise in solving problems. Buddy helped shift teachers away from the model of the authoritarian. While we still saw authoritarian teachers, it is clear that the stance was reduced through Buddy and a more cooperative learning environment involving students and teachers as partners was promoted.

All of the teachers and most of the students and parents we talked to, were aware of the change in relationship. Rather than resisting the loss of power and expertise, the teachers seemed to bask in the glory of the developing expertise of their students. It was exciting of them to see the students being able to teach them. It allowed them to see the students in a new light, recognizing capabilities far beyond what they had previously believed possible. In a similar vein, the students experienced the role of "teacher" with all of its problems and work and witnessed first hand that learning is a lifetime experience.

Willingness to work. All of the teachers and students reported that working on the computer was more fun. It was generally agreed that the students were more willing to do school work and homework on the computer and were more enthusiastic about doing it. This may well have been a temporary effect due to the computers being new; however, we did not see the effect significantly subsiding across grade levels or in schools with four years of involvement.

Improved writing and composition. All teachers reported that using the word processor improved writing skills. This was seen in the amount written and in the details provided in the writing. Several teachers noted that students are no longer asking how long the essay had to be, but rather are asking how long they could make it. Interestingly, it did not mean that spelling was better even though a spell checker was available. The children, almost universally, told us that they liked writing on the computer because it did not hurt their fingers like writing did. It was easier for them to write more, so they did. The professional appearance of the printed papers has raised self-esteem, especially for low ability students. The increased legibility also helped students proof read their own papers more effectively.

Problems

We identified two significant problems in the use of the computer in the classroom. The first was initial student training. The fourth-grade teachers have spent too much time teaching computer mechanics at the beginning of the year. While this has been a problem, all of the schools have already generated their own solutions. Maplewood has designated the whole fourth-grade year as the time to develop computer literacy. The other schools have initiated a Buddy summer school in which the new fourth-grade students received training in the primary applications. The second problem has been maintenance of hardware and of local area networks where most of the software was stored.

Telecommunications

When the students were asked what the Buddy Project meant to them, they overwhelmingly responded "BuddyNet." This electronic network was used to post homework assignments and Brain Teasers, to conduct a summer Buddy Program (at Taft), and to communicate with people from all over the state.

Empowerment

One of the most exciting telecommunications observations is its potential to empower diverse groups (low ability, rural, minorities). The anonymity of the communication minimizes such diverse and often segregating conditions as gender, race, physical appearances and socioeconomic status. In one rural area that has a reputation for racism, the program coordinator reported that this electronic connection has provided the students with positive and otherwise unlikely exposure to racial diversity.

At another school, the students come from a background that gives them limited expectations of their future. This is reinforced by both economic and cultural factors. BuddyNet provides an opportunity for interaction beyond the boundaries of their immediate environment. It allows them to communicate with students from other schools and provides the potential for exposure to new perspectives and higher expectations. Already, teachers have noticed a difference in the students' spelling and grammar as they strive to communicate in this new environment.

Social Outlet

BuddyNet also creates an environment where socially awkward students can find their own niche. While many early computer studies raised concerns over the desocialization caused by excessive computer use, BuddyNet had quite the opposite effect. Shy, quiet students often preferred this vehicle to communicate with teachers and with others of their own age. The network hides physical imperfections and personality flaws which frequently serve to isolate students in the classroom.

Several teachers reported cases where e-mail opened channels with students with whom it was difficult to communicate. They noted that painfully quiet students who they were unable to convince to speak in class often initiated communication through extensive e-mail messages. New students or those who having problems were subtly and easily "touched" in short e-mail messages.

The Mall Syndrome

The chat and e-mail capacities also provide a place for the students to "hang out" socially. In this way it is strikingly similar to the teenage "mall syndrome." Students would pre-arrange to meet each other, or would telephone to see if a friend could get on BuddyNet. The extended network connected students to people in different areas of the state and, for those with *Prodigy* capacity, the country.

Time On-line

Students often preferred spending time on BuddyNet chat or *Prodigy* to watching television. Our data showed little parental concern with the amount of time spent in front of the computer or in front of *Prodigy* which shows more advertising than Whittle's *Channel One*. The interactive nature of the computer made it more appealing to the parents and the communication aspect made it more appealing to the students. There were some complaints of extensive tie ups of phone lines, but families seemed to have worked out time schedules, or were resigned to the belief that the benefits to the child of being on-line outweighed the inconvenience.

Rules and Regulations

Taft, more so than any other school staff, "chaperoned" the students' social use of BuddyNet. There was a nightly curfew and fourth graders were restricted to the school chat channels; general chat was something they graduated to in the fifth grade. Adults were often on-line to remind students to place a period at the end of a sentence or to serve as a presence that encouraged a higher standard of interaction. Linden, in comparison, had few rules and no curfew.

Facilitating Home-School Communication

The e-mail function had a variety of levels of uses for facilitating communication between home and school. The most common "use" was the perception that the lines between home and school were more accessible. Because homework assignments are often listed on the school bulletin boards, it is difficult for students to tell their parents that they have no homework, and teachers, parents and students credit this factor for the increase in assignment completion.

Personal Invitation

Teachers found that when the students read their assignments over the computer, they were more likely to be motivated to complete them. One teacher theorized that perhaps his requests seemed more personalized when they were seen on the students' home monitor.

> I think standing in front of the class, they can see that you're talking to everyone. I'm not sure when they read it on their computer that they realize that you wrote that same message to everyone. I think if you asked them about it they'd understand that, but somehow because it is one letter to them in their house it is personalized; and then, they had to write back to me personally.

Real-Life Applications

BuddyNet provided real-life opportunities to communicate in the written form. Teachers emphasized that this writing practice was more likely to occur in the e-mail mode than in the chat channel. In e-mail and on the bulletin boards the students were more likely to write full sentences and paragraphs. For example, one principal received an unprompted e-mail note from a student protesting the school ban on remote control cars. What pleased the principal most about the letter was the student's initiative and the real-life purpose behind the communication.

Tutoring On-line

The electronic functions opened some unexpected gateways to learning. One student with a severe reading learning disability was "adopted" by a woman in another community. The two met on-line every night and through "chatting" improved the girl's reading and writing skills. Adults noted that the written format of the highly popular chat and e-mail has a positive influence on the students' reading and writing proficiency.

Summer School

Taft, the rural school, conducts its summer Buddy program on-line. Prior to the introduction of the Buddy System Project, none of the teachers at Taft taught summer school classes. The school building was closed for the summer. Any Taft student who wanted to participate in summer programs (for either enrichment or remedial reasons) had to be driven into the nearest town, which is almost twenty minutes away. In contrast, the on-line learning environment created in BuddyNet is easily accessed and can be attended to at a time that is convenient to each individual student and teacher. The on-line projects allow and encourage all levels and abilities of students to stay involved with learning over the summer months. They reinforce what had been learned the previous year, explore new topics and provide a way for teachers to become more familiar with the students and their needs before the class physically convened.

Problems

Forgotten or mis-entered passwords were a frequent source of confusion for new users. Mis-loaded software also prevented many new users from logging-on for several weeks, by which time they had forgotten the procedure. Using the telecommunications feature rendered the family line busy. If the family had call waiting, an in-coming call would bump the user off of the network. Both of these situations were considered nuisances by the participants.

Family Involvement

This section concentrates on the information culled from home visits. Research of home use of personal computers is, to date, lacking. One goal of the Buddy System Project is to support the entire family in developing computer skills and in integrating the computer into their daily lives. Home visits and family interviews provided insight not only into family computer use, but also into the home computer's role in the child's education.

Use of the Computer

Use by Parents. The two most popular activities among the parents were the use of *BuddyNet* and *Prodigy*. The chat channel was by far the most popular use of BuddyNet. Parents and children alike spent long hours simply talking with other people on the system. Most often this was general social chatter. However, the effect was not always neutral. For example, through the Buddy chat channel, one parent learned of another parent's problems with a water heater on Thanksgiving Day and was able to give advice over BuddyNet on how to make the repair. At the other end of the spectrum, there have been numerous instances of foul language and flirting by the parents on BuddyNet.

There were some instances of the use of the Buddy computer to help with work-related tasks, but this was infrequent. Most often the computer was used as a word processor to generate letters, newsletters, or announcements. One mother used the system to keep records from her job as a nurse. However, the removal of the computer for the summer inhibited her from continuing that activity when the computer was returned that following school year. Several parents noted that they used the BuddyNet to contact and communicate with the parents and members of their scout troops. Another parent told us of a school committee meeting that was held on-line because it was more convenient and time efficient than driving to a common meeting place.

Often we heard about parents' plans to use the computer -- plans that never seemed to be realized. For example one parent who is in sales indicated he intended to use the computer to maintain a client database. However, when we returned three months later, he told us that he had not done anything yet because he had long hours, as well as a lot of travel with the job. Another parent indicated that she would like to use the computer for family budgeting, while a third indicated that he saw it as a mechanism for managing his stamp collection. Finally, one parent saw the computer at home as making it easier to take a computer class that would help her develop the computing skills necessary for secretarial work. However, she was still too unfamiliar with the computer and it's uses to be able to express just what skills she needed.

Use by siblings. The use by the brothers and sisters of the Buddy child is dominated by games and BuddyNet. The children do not seem to distinguish between educational and non-educational games. That classification seems to be one that we as adults impose. Graphic programs are also popular with younger siblings, but generally not with older siblings. It is interesting to note that the siblings in the families we interviewed did not use the computer for their homework. This was true even with siblings who were "Buddy alumni." This reinforces the notion that the effective use of the computers requires the creation of a culture for its use.

Buddy home computers have contributed to general dissemination of computer knowledge. Students entering the fourth grade are increasingly familiar with the buddy computers and software; even those who have not had a computer in their home yet. At one school in its fifth year of implementation, approximately half of the members of the incoming fourth-grade class were familiar because of their exposure to neighbors' and siblings' Buddy computers. Parents noted that the home computers had made them more comfortable with and aware of hardware, software, and the potential held by the development of computer related skills, such as word processing.

Homework

Parent involvement in homework. In many cases there was no change in the parents' level of involvement with homework. However, across the schools we did see three types of effects. First, the newness of the technology and the child's expertise attracted the parents to the activity. They would share the homework time with the student, learning the technology as the student did. Second, the activities of the school required the parents to be more involved. This was the case at Plainview. Parent involvement remained high as long as there was a requirement. Finally, some parents were frustrated in their attempts to work with the child because they did not know how to use the software and hence could not provide help.

Dealing with divorce. The effective use of the computer for homework is a complex issue because of the structure of family units in our modern society. Specifically, a large proportion of the students in three of the schools come from families where the parents are separated or divorced but with both parents still living in the same general area. As a consequence, the children actually reside in two homes; the mother's and the father's. Their access to the home computer depends on whose home they are in for the evening. The teachers have used three strategies to manage this problem. First, use of the computer for homework is made optional. Students may do it on the computer or not, as they see fit. Second, the computer homework is a means of achieving extra credit. If the homework is done, then bonus points or some other reward is given. Third, the student is given time to work on the computer homework assignment at school.

Parent-School Linkages

We found that while parents agreed that the program improved parent/school relations, they did not perceive as great an improvement as the school staff had. Both recognized that the logistics of getting the equipment home required an increase in the number of contacts between teachers and parents. Because these contacts were for an action considered to be neutral or positive (instead of a negative confrontation over the child's grades or behavior) teachers and parents noted that they felt communication had improved. Perhaps the electronic communication's greatest "usefulness" was not an increase in actual communication, but rather an increase in the *perception* that the lines of communication between home and school were more accessible.

Buddy also facilitated the opportunity for school staff to visit homes. Setting up the home Buddy computer sometimes created a need for a visit from a school staff member. Taking the initiative to meet the family on their "own turf" under positive circumstances was well received by the families. Through seeing the home situations of students, the teachers were able to gain a better understanding of behavior observed in school.

The BuddyNet e-mail and bulletin board functions are also used to facilitate communication between home and school, as well as to get parents more involved in their child's education. Teachers who actively established improved communication with parents as a high priority used successful tactics such as requiring parental e-mail each night upon student completion of homework. Other teachers post assignments that require the involvement of family members. The posting of "brain teasers" at one school has become a well received family activity. The program's emphasis on family involvement has received mixed reviews from parents. Some felt that these assignment checks were an imposition, others, often those who were already involved, were pleased with how easily they could now stay in touch with their child's work. One mother noted how excited she was because her husband's interest in the computer had enticed him to get involved in their son's schoolwork for the first time.

Empowerment at Home

The position of the student within the family structure was considered by many to be enhanced. For one mentally handicapped girl, her knowledge of the computer offered her the chance to be a "contributing member of the family for the first time." Another mother was surprised at a mutually interesting conversation with her son about her work with databases. Parents interviewed said that their opinions of what the children were capable of achieving had increased dramatically since involvement in the program.

Problems

There were varied reports of family tensions and anxieties caused by the introduction of the computer into the house. The extensive tie up of telephone lines for electronic communications use was the most highly reported problem. Adult use of "chat channel" for reasons ranging from extensive time on-line with friends to flirting was also recognized as a source of tension.

Conclusion

Buddy was successful in all of the schools. The computers were enthusiastically received and were being used extensively. There was a high use of tool-based software that permitted the students to generate and process information, and a minimum use of the computer for rewarding behavior or for rote instruction. Further there has been a renewal effect on the teachers and a positive impact on the culture of the classroom. In this section we examine what we feel are factors that underlie the most successful implementation of the program.

Length of Time in the Project

It was clear from observations and interviews that the first year a school is involved requires an enormous amount of work. The logistics of getting the computer into the homes takes an incredible amount of planning and energy, and no amount of helpful hints takes the place of actually going through the process. In addition to logistical concerns, teachers and students are learning how to use the software and what they can do with it.

High Computer Access

We heard over and over again that the computer activities were only possible because there were computers at school and at home. If the teachers are to engage in larger, student-centered projects, it simply can't all be done at school. The home computers permit the teachers to expect the school projects to continue at home and thus permit them to assign larger projects.

A Student-Centered Instructional Model

The computers are a vehicle for the students to create and manipulate information. This use of the computers is most successful in a student-centered approach to learning, when they are used to contribute to project-based learning. In contrast, the teachers at Linden tended to provide very detailed instruction to the students as to what they will create, with very few degrees of freedom left to the students. One of those teachers expressed a wish that all the students could have their own computer so everyone could be doing the same thing at the same time all under her direction. We have doubts as to whether this teacher can be success with that philosophy.

A Purpose for Using the Computers

If the computer is to be a tool for learning, then it is essential that the plans for using the computers begin with learning goals. That is, instructional goals and not computer goals must drive the activity. However, the computers offer new opportunities for thinking about and working in the content areas. It is not adequate to simply reflect on traditional learning goals; rather it is necessary to consider what new opportunities for learning and understanding are available. There is not such thing as "just another tool." Each tool for learning offers particular opportunities for learning and understanding and we must understand the strengths and potentials so that it is a tool that is used effectively.

Teachers Attuned to Adoption of Innovations

It seems to us that a significant factor in successful implementation is the presence of several innovators; teachers or administrators ready to take chances, work at the cutting edge, and lead the way for the others at the school. In addition the success of the program would not have been possible without a large amount of extra effort on the part of the teachers. All the teachers reported spending long hours learning about software and trying to "keep up with the students." In all cases the teachers reported that the effort was well worth it. They saw the value of the computers, embraced the opportunity, and were willing to spend long hours.

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Title:

A Survey of Media and Instructional Technology Competencies Needed by Business, Industry, Health Professions, Agencies, Military Trainers, and Independent Contractors in Northern California, USA

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A Survey of Media and Instructional Technology Competencies Needed by Business, Industry, Health Professions, Agencies, Military Trainers, and Independent Contractors in Northern California, USA

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Purpose of the survey. Many professionals working as instructional designers and/or trainers in business and industry have been or are currently enrolled in universities programs specially designed to meet their needs, throughout the United State and abroad. In order to better prepare these professionals, and to insure they have the needed competencies, understandings, knowledge and skills, it is important for us to know the value of what we do as perceived by those who are enrolled in our preparatory programs. Do university graduate programs contain appropriate content and the emphasis necessary to prepare instructional developers for positions in business and industry? What are important training formats used by professionals working in business and industry training programs? What are some of the emerging platforms? What are some of the strengths and weakness of current university programs ? What currently offered content areas should be replaced? Strengthened? Added?

The survey instrument. San Jose State University developed a 54 item survey instrument based on selected major competencies needed by industry and business professionals as perceived by a select group of university professors working in the Bay Area of Northern California (Appendix I). Items ranged from those dealing with basic demographic data (such as gender, work setting, years in present position, salary level, degrees earned, subject areas or grades previously taught) to those dealing with designing and producing instructional materials and instructional systems, content focus and emphasis, formats for delivering instruction, delivery systems and media for instruction (such as computer-based learning, stand-up lecturing, etc.), grant and proposal writing skills, the evaluation process, and "soft" skills such as conflict resolution and stress management. Items included fill-in-the blanks items in Section I and scaled items in Section II.

Population description. Subjects included members AECT, San Francisco Bay Area Chapter, NSPI, IICS and SJSU IT graduates. Many of the subjects are significant IT leaders in the Silicon Valley in the companies such as Lockheed Aerospace, Apple, IBM, Hewlett-Packard, Amdahl, Sun Micro systems and others. A total of two hundred and sixty seven (267) survey instruments were distributed. Sixty-six (66) usable surveys were returned, a 25% return rate.

Demographic and personal data. In addition to the usual demographic data required to gain needed understanding of the survey participants, additional questions which were of interest to the researchers were included in Section I of the survey, including:

- Do male instructional designers have higher incomes than female counterparts?
- What's the salary range of the professionals who responded to the survey?

Summary of Section I Data: General Information.

A total of sixty-six (66) usable responses were collected. Note that percentages given were calculated excluding missing cases (item for which no answers were given by a particular individual survey participant).

Gender. 38 female (57.6%) and 27 males (40.9%). One subject did not specify the gender.

Current position. Subjects were asked to mark all that apply.

• Instructional designer/curriculum developer	42 responses
• "Stand-up" instructor	18 responses
• Training manager	7 responses
• Media and production specialist	7 responses
• Independent contractor	13 responses
• Other	13 responses

Responses listed under "Other" included manufacturing manager, program/project manager, consultant, academic dean, and software engineer.

There are a total of 100 responses from 66 subjects. This indicates that many of the instructional designers/trainers "wear two hats".

Work setting. Work settings of survey participants are presented below.

• Business or industry training	42 responses
• Health professions training	1 response
• Agency (law enforcement, military, etc.)	1 response
• College or university	12 responses
• Other	11 responses

Responses under "Other" included CEO of a training development company, worldwide video conference, network manager, educational technologist, leader, upper level management, high school instructor, education, multimedia software development, quality assurance, and librarian. Some participants checked more than one work setting. Seven (7) subjects did not respond to the work setting item.

Years in present position.

• 1-3 Years	27 responses (41.5%)
• 4-6 Years	12 responses (18.5%)
• 7-10 Years	9 responses (13.8%)
• 11- 15 Years	6 responses (9.2%)
• Over 15 years	11 responses (16.9%)

One (one)1 subject did not respond to this item.

Salary level.

• $20,000 - $30,000 Year	3 responses (4.8%)
• $31,000 - $40,000 Year	11 responses (17.5%)
• $41,000 - $50,000 Year	13 responses (20.6%)
• $51,000 - $60,000 Year	15 responses (23.8%)
• Over $60,000 Year	21 responses (33.3%)

Three (3) subjects did not respond to this item.

Degrees earned. Subjects were asked to mark all that apply and list academic majors.

• AA or AS:	8 responses
• BA or BS:	45 responses
• MA or MS:	47 responses
• Doctorate:	13 responses

Majors listed included Instructional Technology, MBA, Computer Science, Sociology, Home Economics, Mass Communications, Journalism, Business, Nursing, Political Science, History, Library Science, Social Studies, Educational Administration, Electrical Engineering, Educational Psychology, Computer Engineering, Mathematics, Art, Physics, Psychology, Hispanic Civilization, English, Advertising, Anthropology, Math, Biology, Zoology, Theater Arts, Liberal Studies, Social Science, and Ancient and Modern languages. One subject had not earned a post-secondary degree. Most frequently listed majors included Instructional Technology, Business, Education, and Social Studies.

Areas taught prior to the current assignment. Subjects were asked to mark all that apply.

• K-8 school classroom	12 responses
• 9-12 school classroom	18 responses
• Community College	22 responses
• University	18 responses
• Other	21 responses

The listing under "Other" included non-profit organization, professional association, private language school, private business school, private industry, seminars, workshops, Peace Corps, sales, software industry, adult education, Fortune 500 companies, and the military.

Items which were not included on the instrument but which may be important. Items which might be added to the survey competencies found in the instrument were listed by participants. Included were public speaking, team skills, negotiation skills, vender management (developing criteria, interviewing, evaluation), management expertise, electronic performance support systems and applications, knowledge engineering, information mapping, hypertutoring, curriculum design, summative evaluation, practices in business management, crisis intervention, technical writing skills, evaluation, design and development of simulation and games, role playing, group dynamics, consulting skills, corporate training, writing skills.

The most frequently suggested items included those relating to writing skills, evaluation, and management skills.

Summary of Section II Data: Competencies, Understanding, Knowledge, Skills.

Percentages of professionals who considered the competency, understanding, knowledge or skill to be important or a high priority are presented below, followed by the rank-order of that item in relation to other items included in the survey. Percentages of respondents who were undecided, gave the item a low priority, or suggested that the item be eliminated from consideration are also presented below.

COMPETENCY, UNDERSTANDING, KNOWLEDGE OR SKILL	IMPORTANT OR HIGH PRIORITY PERCENTAGE	RANK
92.4% to 100% of the respondents consider competency to be important or high priority		
Knowledge, understanding and applications of instructional design models and principle	100.0%	1
undecided 0.0%		
low priority ... 0.0		
eliminate 0.0		
Learning needs assessment and evaluation; understanding, skills and applications	96.9%	2
undecided 3.1%		
low priority ... 0.0		
eliminate 0.0		
Project management, from inception to completion	93.9%	3
undecided 4.5%		
low priority .. 1.5		
eliminate 0.0		
Design, production and utilization of self-paced learning materials	92.4%	4
undecided 6.1%		
low priority ... 1.5%		
eliminate 0.0		
81.5% to 89.4% of the respondents consider competency to be important or high priority		
Instructor-led training, including skills necessary for giving effective presentations	89.4%	5.5
undecided 7.6%		
low priority 3.0		
eliminate 0.0		
Design, production and utilization of independent learning modules	89.4%.	5.5
undecided 7.6%		
low priority 3.0		
eliminate 0.0		
Learning theories, including adult learning and cognition	87.9%	7
undecided 9.1%		
low priority 1.5		
eliminate 1.5		

Use of computers in word processing, data bases, and spread sheets .... 86.4 % 8
undecided 4.5%
low priority 6.1
eliminate 3.0

Computer based training and computer assisted instruction 83.3% 9
undecided 15.2%
low priority 1.5
eliminate 0.0

Project proposal writing, including all essential elements needed for funding success 83.1% 10
undecided 10.8
low priority 3.1
eliminate 3.1

Desk-top publishing, including basic design, layout and production 81.5% 11
undecided 9.2%
low priority 9.2
no response 1.5

70.3% to 78.8% of the respondents consider competency to be important or high priority

Design, production and utilization of video instructional materials 78.8% 12.5
undecided 12.1%
low priority 9.1
eliminate 0.0

Evaluation and selection of "off-the-shelf" training materials 78.8% 12.5
undecided 13.6%
low priority 7.6
eliminate 0.0

Design, production and utilization of multi-media programs, including hypermedia 75.8% 14
undecided 19.7%
low priority 4.5
eliminate 0.0

70.3% to 78.8% of the respondents consider competency to be important or high priority

Computer graphics, including basic design, layout and production 74.2% 15.5
undecided 10.6%
low priority 15.2%
eliminate 0.0

Design, production and utilization of instructional interactive video 74.2% 15.5
undecided 15.2%
low priority 10.6
eliminate 0.0

Basic research understanding, skills, competencies 73.8% 17
undecided 18.5%
low priority 7.7
eliminate 0.0

Crosscultural communication and relationship skills and understanding 70.3% 18
undecided 17.2%
low priority 10.9
eliminate 1.6

60.0% to 69.7% of the respondents consider competency to be important or high priority

Time management, including time-line development and applications 69.7% 19
undecided 18.2%
low priority 9.1
eliminate 3.0

Telecommunications, including knowledge, understanding, skills and applications 65.2% 20
undecided 24.2%
low priority....... 9.1
eliminate........... 1.5

Distance education, including administration, cost effectiveness, technical requirements 63.6% 21
undecided 27.3%
low priority 9.1
eliminate 0.0

Design, production and utilization of displays, including interactive and self-instructional displays 61.5% 22
undecided 15.4%
low priority 20.0
eliminate 3.1

60.0% to 69.7% of the respondents consider competency to be important or high priority

Administration and management models and principles 60.6% 23
undecided 27.3%
low priority 9.1
eliminate 3.0

Client centered management theory and implementation 60.0% 24
undecided 27.7%
low priority 9.2
eliminate 3.1

51.5% to 56.1% of the respondents consider competency to be important or high priority

Interpersonal relationship theory, skills and applications 56.1% 25
undecided 24.2%
low priority 12.1
eliminate 7.6

Financing, budgeting and depreciation 55.4% 26
undecided 30.8%
low priority 13.8
eliminate 0.0

51.5% to 56.1% of the respondents consider competency to be important or high priority

Design, production and utilization of overhead projection transparencies 54.5% 27
undecided 18.2%
low priority 22.7
eliminate 4.5

Organizational development theory and applications 52.3% 28
undecided 24.6%
low priority 20.0
eliminate 3.1

Futures studies, trend indicator extrapolations, development of alternative futures 51.6% 29
undecided............ 26.6%
low priority 18.8
eliminate 3.1

51.5% to 56.1% of the respondents consider competency to be important or high priority

Design, production and utilization of audio instructional materials 51.5% 30.5
undecided 18.2%
low priority 28.8
eliminate 1.5

Conflict resolution theory, skills and applications, and stress management 51.5% 31.5
- undecided 22.7%
- low priority 16.7
- eliminate 9.1

41.3% to 44.6% of the respondents consider competency to be important or high priority

Design, production and utilization of photographic instructional materials 44.6% 32
- undecided 26.2%
- low priority 26.2
- eliminate 3.1

Design, production and utilization of flip charts, posters and other flat graphics 41.5% 33
- undecided 29.2%
- low priority 21.5
- eliminate 7.7

Facilities design and/or modification for media design, production, utilization 41.3% 34
- undecided 36.5%
- low priority 15.9
- eliminate 6.3

Conclusions. A comparison of university curricula with the data summary presented above indicates that many university curricula need to be examined and revised in order to meet the needs of professional trainers and instructional designers in the field.

Most university programs include many of the "basics" needed by trainers and instructional designers, but have "gaps" which could be filled by including courses in areas dealing with human relationships and overseeing projects or programs.

Facilities design and some of the more familar and comfortable media were not considered as important as courses or competencies in dealing with other human beings, and management and administration.

Further research is needed. The questionnaire could be revised to include addtional items suggested by participants in this study. More subjects and subjects in other settings should be surveyed. Although many trainers work in agencies, only one agency trainer was included in the survey. Health professions trainers also need to be surveyed in depth.

Additional data have been received since the conclusion of the writing of this report. A more comprehensive analaysis of data will be prepared for publication in the near future.

For a copy of the results or additional information concerning the study, please contact:

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A SURVEY OF MEDIA AND INSTRUCTIONAL TECHNOLOGY COMPETENCIES
NEEDED BY
BUSINESS, INDUSTRY, HEALTH PROFESSION, AGENCY AND MILITARY TRAINERS
IN NORTHERN CALIFORNIA, USA
FALL 1992

DIRECTIONS FOR RESPONDING TO THE SURVEY INSTRUMENT. **Please respond by filling in your response** on the enclosed Scantron answer sheet next to the number which corresponds with the number of the question on the enclosed survey instrument. **Skip** the left side of the Scantron sheet where it needs name and social security numbers,etc. All information provided by you through your individual responses to the survey instrument will be kept strictly confidential. Please return the questionnaire And Scantron form in the envelope provided for your convenience, or fax the materials to us at (408) 924-3713. If you would like to have a summary of our findings, please write your name and address on the back of this instrument or call Mei-Yan Lu at (408) 924-3645.

PART I: GENERAL INFORMATION

Mark all that apply with a soft lead pencil on the enclosed answer form, for items 1 - 53.

1. Gender: (a) Female
(b) Male

Items 2 -7 describe your current position, please mark the one(s) that best describe(s) your job:

2. Position: Mark all that apply.
3. (a) Instructional designer/curriculum developer
4. (a) "Stand-up" instructor
5. (a) Training manager
6. (a) Media and production specialist
7. (a) Independent contractor
Other: Please describe here ______________________________
8. Work setting: (a) Business or industry training
(b) Health professions training
(c) Agency (law enforcement, military, etc.)
(d) College or university
Other: Mark "e". Please list ______________________________
9. Years in present position:
(a) 1-3 Years
(b) 4-6 Years
(c) 7-10 Years
(d) 11- 15 Years
(e) Over 15 years
10. Salary level: (a) $20,000 - $30,000 Year
(b) $31,000 - $40,000 Year
(c) $41,000 - $50,000 Year
(d) $51,000 - $60,000 Year
(e) Over $60,000 Year

Items 11 - 14. Degrees earned. Please mark the degree(s) you have:

11. (a) AA or AS: List degree major ______________________________
12. (a) BA or BS: List degree major ______________________________
13. (a) MA or MS: List degree major ______________________________
14. (a) Doctorate: List degree major ______________________________

Items 15 - 19. Areas you have taught. Please mark all that apply:

15. (a) K-8 school classroom
16. (a) 9-12 school classroom
17. (a) Community College
18. (a) University
19. Other: Mark "e". Please list______________________________

Section II: Instructional Technology Professional Knowledge, Understanding and Competencies

Please consider each of the items which follow in light of what you feel is important for performing as a highly competent and well-rounded instructional technology professional. **Do not limit your responses by considering only what is needed by you to perform well in your current position.**

Mark "a" if you consider the item listed to be essential; should be assigned a high priority.
Mark "b" if you consider the item listed to be important; should not be assigned a very high priority.
Mark "c" if you are undecided as to whether the item is important or unimportant.
Mark "d" if you consider the item to be relatively unimportant; should be assigned a low priority.
Mark "e" if you consider the item to be irrelevant; should be eliminated from consideration.

20. Knowledge, understanding and applications of instructional design models and principles.
21. Instructor-led training, including skills necessary for giving effective presentations.
22. Use of computers in word processing, data bases, and spread sheets.
23. Computer graphics, including basic design, layout and production.
24. Desk-top publishing, including basic design, layout and production.
25. Computer based training and computer assisted instruction.
26. Design, production and utilization of instructional interactive video.
27. Design, production and utilization of multimedia programs including hypermedia programs.
28. Telecommunications, including knowledge, understanding, skills and applications.
29. Distance education, including administration, cost effectiveness, technical requirements.
30. Design, production and utilization of overhead projection transparencies.
31. Design, production and utilization of audio instructional materials.
32. Design, production and utilization of video instructional material.
33. Design, production and utilization of photographic instructional materials, including prints and slides.
34. Design, production and utilization of instructional flip charts, posters and other flat graphics.
35. Design, production and utilization of effective displays, including interactive and self-instructional displays.
36. Design, production and utilization of self-paced learning materials.
37. Design, production and of utilization of independent learning modules.
38. Evaluation and selection of "off-the-shelf" training materials.
39. Learning needs assessment and evaluation: understanding, skills and applications.
40. Learning theories, including adult learning and cognition.
41. Conflict resolution theory, skills and applications, and stress management.
42. Interpersonal relationship theory, skills and applications.
43. Administration and management models and principles.
44. Time management, including time-line development and applications.
45. Client centered management theory and implementation.
46. Organizational development theory and applications.
47. Project proposal writing, including all essential elements needed for funding success.
48. Program management, from inception to completion.
49. Finance, budgeting and depreciation.
50. Basic research understanding, skills, and competencies.
51. Crosscultural communication and relationship skills and understanding.
52. Futures studies, trend indicator extrapolations, development of alternative futures.
53. Facilities design and/or modification for media design, production, utilization.

Please add items you think are important that are missing from the preceding list in the space below.

Thank you very much for your time, and sharing your professional judgement with us.

Title:

The Critical Role of the ID in Interactive Television: The Value of Immediacy

Authors:

Karen L. Murphy
Charlotte W. Farr

The Critical Role of the ID in Interactive Television: The Value of Immediacy

Introduction

Interactive television, or video conferencing, includes compressed digital video conferencing, ITFS, and microwave television. Video conferencing has opened new avenues for delivering high quality instruction to greater numbers of students in higher education. This is true at the University of Wyoming and in several other states where video conferencing has been instituted statewide in higher education. With the potential for offering high quality instruction to large numbers of higher education students, however, has come challenges to the administration, to instructors, and even to the students. One of these challenges is to minimize barriers to learning [illegible] a distance, as distant students tend to feel isolated and left out. Whittington's (1987) research shows that no significant difference is found between learning outcomes in face-to-face instruction and in instruction that is mediated by technology. However, wide gaps do exist in student attitudes toward learning, some of which have been shown to influence student achievement.

While it may be possible for campus-based instructors to get away with lecturing for three hours each week in class, this kind of approach is totally inappropriate for instructors teaching via video conferencing. Can you imagine trying to learn by watching a television monitor from across a large room for such extended periods of time? The challenge to the distance instructor becomes even greater when the instruction is primarily lecture, with some charts, graphs, and text to "liven up" the lesson. It is particularly important for distance instructors to incorporate behaviors in their teaching that will reduce the learners' sense of physical and psychological distance.

One way to reduce this sense of distance is for instructors to use immediacy behaviors, or communication behaviors that "enhance closeness to and nonverbal interaction with another" (Mehrabian, 1969). Immediacy behaviors convey approachability and communicate interpersonal warmth and closeness. Typical immediacy behaviors include the use of a variety of vocal expressions when teaching, having a relaxed body position when talking to the class, and smiling at the class as a whole. The "social presence," or the ability to approximate the characteristics of face-to-face interaction, is obviously limited in mediated instruction. Correlations have been found between immediacy and student expectancies (Giglio & Lustig, 1987) and between immediacy and student motivation (Christophel, 1990), which in turn result in higher achievement. Thus, instructors who employ immediacy strategies to increase perceived social presence are likely to enhance both student learning and satisfaction in video conferencing classes.

A key figure in increasing immediacy behaviors among distance teaching faculty is the instructional designer. This individual plays a critical role in the development and continuing viability of each course taught at a distance. The role of the instructional designer has three components: in relationship to the infrastructure, in relationship to the technology, and in relationship to people--specifically, students and faculty. First we will discuss the relevance of immediacy behaviors to distance education, particularly in video conferencing environments. Following is a discussion of ways that the instructional designer can help foster immediacy teaching behaviors through the infrastructure, the technology, and the people involved in video conferencing.

While the focus is on interactive video conferencing, similar strategies can be used to achieve similar results with less interactive distance teaching technologies. These "non-interactive" technologies include one-way video transmission, either through satellite teleconferencing or broadcast or cable television, or even videotapes. All of these technologies are usually supplemented with printed materials which are sent to students at their distance learning locations.

Immediacy in the Context of Distance Education

Compelling evidence exists in traditional face-to-face learning contexts that decreased physical and/or psychological distance between teachers and students is associated with enhanced learning outcomes. Lawrence Rifkind (1992) summarized research on immediacy as a predictor of teacher effectiveness and learner achievement in the interactive television classroom. Studies primarily in the area of communication have found positive correlations between immediacy and cognitive achievement as well as between interactive television system design and cognitive achievement (e.g., Christophel, 1990; Giglio & Lustig, 1987; Gorham, 1988).

Mediated learning is most effective when students perceive a personal involvement in the educational process. Helping distant students become personally involved in their mediated education is achieved through "guided didactic conversation" (Holmberg, 1984). Holmberg describes internalized conversation as occurring through interaction with course material, and externalized interaction as conducted directly with the instructor verbally by telephone or other telecommunication means. In addition to these two forms of interaction, it is generally understood that a third type of interaction is conducive to learning and is particularly important in distance education:

interaction among the learners themselves (Moore, 1989). University of Wyoming course evaluations indicate that when students interact with other students in the class, they find the class both intellectually stimulating and personally relevant (Farr, 1992). While the instructor may not play a strong role in this kind of interaction, the sense of immediacy is clearly present within the local groups.

How can distance faculty guide their students' didactic conversation? Unfortunately, faculty members designated as distance education instructors typically lack the knowledge and expertise to adapt their courses successfully to distance delivery on their own (Farr, Murphy & Flatt, 1992). Therefore, faculty development needs to occur. Faculty development should focus on the concept of immediacy to engage students in didactic conversation. Students who engage in didactic conversation (with the instructor, the content, or each other) are likely to perceive their personal involvement in the learning process as more satisfactory.

Immediacy and the Infrastructure

Instructional designers are a vital part of the infrastructure that provides the interactive television system. These individuals should participate in the decision-making that will impact policy statewide. They are more likely to have firsthand knowledge of the factors that influence scheduling, faculty needs, new product development, and technological problems. With this knowledge base, instructional designers can assist distance education instructors in identifying and practicing the kinds of teaching strategies that enhance immediacy.

In Wyoming, the infrastructure includes the following: the seven community colleges (which together with the University of Wyoming comprise the current state telecommunications network); six academic coordinators who are located at community colleges; colleges and departments at the University of Wyoming; other users on campus; the state telecommunications system; the telecommunications service provider; and the vendor.

At the University of Wyoming, the instructional designers were involved tangentially in the decision-making regarding the purchase of the compressed digital video conference equipment. Since the purchase and installation of the equipment, however, the instructional designers have been involved in literally all aspects of the infrastructure. The instructional designer maintains contact with the students at all sites, first through a student orientation and subsequently by monitoring individual sessions and conducting formative evaluations. These forms of contact are particularly pertinent in promoting immediacy behaviors of students whether they meet face-to-face with their instructor or learn at a distance. The responsibilities of the instructional designer associated with the infrastructure include:

- * providing a student orientation and monitoring classes;
- * conducting live formative evaluations in courses;
- * spearheading weekly conference calls with the State Division of Telecommunications and US West;
- * arranging and conducting workshops for academic coordinators, instructors, and administrators on the use of the system;
- * maintaining ongoing contact with the far-flung academic coordinators and the site facilitators, and on-campus producer/directors and engineers;
- * monitoring and integrating audio, video, and computer-based technologies.

Immediacy and the Technology

The technology of compressed digital video conferencing is fairly recent in higher education, although business and industry have been using the technology for over a decade. The University of Wyoming has recently implemented a statewide compressed video conferencing system. What are the critical attributes of video conferencing?

* Video conferencing provides two-way interactive video and audio transmission among two or more sites simultaneously. That means that students in widespread locations can see and hear their instructor as well as each other almost as if they were in the same room.

* Video conferencing also enables live transmission and annotation of text and graphics. Instructors and students can use a hand-held control to activate a special camera that transmits images and graphics to the other sites. Then they can annotate these "slides" from their own locations using a graphics pad and pen.

* The same hand-held remote control can be used to zoom in on the face of a speaker.

* Peripherals enable films and videotapes to be shown in real time over the system.

* Because video conferencing is PC-based, the system allows the demonstration of computer software in a point-to-point conference by

means of telecommunications programs such as PCAnywhere. In addition, instructors can show slides of the software program to all students in multi-point conferences.

* Video conferencing digitizes video and sound, which are sent over telephone lines to other locations, where they are converted back to images and sound. Because the entire picture is not being transmitted continually as in the case of broadcast video, the images and sound seem to be slightly distorted.

How can these attributes be used to foster immediacy in distance teaching/learning contexts? Instructional designers can assist faculty, students, and even producer/directors and camera operators in exploring and capitalizing on the attributes of video conferencing.

The University of Wyoming instructional design procedure connected with the technology follows: The instructional designer him/herself must first learn to use the technology. Then the instructional designer must figure out teaching strategies that exploit these attributes. Next the instructional designer works with individual instructors on their needs, objectives, and teaching strategies. Only then can the instructional designer help an instructor select and practice immediacy behaviors with the technology.

Specific ways that the instructional designer can exploit the attributes of video conferencing to foster immediacy behaviors include:

* Teach instructors and students to use the equipment so that they can send and receive slides and graphics, and use the graphics tablet for annotating graphics.

* Train site facilitators, or monitors at each receiving location to assist the instructor in the use of the technology.

* Work with a camera operator, the instructor, or a facilitator who does the camera work at the teaching site to pan around or zoom in for extreme close-up of the face of the instructor.

* Work with a producer/director in a television studio to use visual effects to show the instructor's graphics and the face of the instructor simultaneously. These effects avoid having students at receiving locations view only the graphics for extended periods of time.

* Ensure that students are seated so that they can view the monitors comfortably. Students should also have easy access to microphones and

be trained in advance in the use of the microphones to avoid "microphobia."

* Ensure that instructors use hands-free microphones so that they can devote their attention to teaching, interacting with students, and using the equipment effectively.

Immediacy and the People

Students

At the beginning or even prior to the first class session, the instructional designer conducts an orientation to learning via video conferencing. This orientation may include a training videotape. Orientation sessions should enable students to practice using the video and audio equipment, including microphones, and ideally should provide guidelines to success in learning via video conferencing.

The instructional designer must ensure that site facilitators are well trained in the use of video conference equipment. At a receiving location, the site facilitator, whose primary responsibility is to assist the instructor, can also act as an advocate of the students. During class sessions these facilitators can inform the instructor when shy students want to participate but may be reluctant to speak up or use the microphone. Outside of class they can help students design graphics that are appropriate for the medium and provide practice with the graphics pad and pen as the students prepare for their presentations.

Faculty

Faculty members often need to be convinced to teach via video conference. Once convinced, they need to learn to alter their teaching methods to be more appropriate for teaching via video conference. Distance teaching faculty have been found to be preoccupied with determining the course content and matching the content to the time available, with little attention paid to the delivery of instruction and the intended learning outcomes (Wolcott, 1991). As described earlier, the core of faculty development should be immediacy behaviors to engage students in didactic conversation. Faculty development involves identification of ways to exploit the attributes of the technology with the intention of creating a positive learning environment for all distant students. Instructional designers should help faculty focus on the three modes of interaction: instructor-students, student-student, and content-student (Moore, 1989).

Following is a description of the faculty development process at the University of Wyoming. This process helps the faculty look at the distance learner as the nucleus. The instructor receives assistance from the instructional designer through workshops and individual sessions, from the office through its coordination, and from evaluations.

Workshops - Faculty development workshops occur in two parts. The first part focuses on general information about distance education, including information about the ways that the system is coordinated at the university and throughout the state. In this part the instructional designer doesn't teach specifically about any given distance education technology. Instead, the faculty are introduced to the philosophy of distance education, they gain an overview of all delivery systems, and they learn what is required of them to prepare for their course, which they will teach the following semester. This segment is conducted by video conference, so that faculty who will teach from other sites can participate as well. Thus the faculty are introduced to a technology by using it, and they observe appropriate teaching strategies and behaviors that the instructional designer models for them.

The followup part of faculty development workshops focuses on applications to specific delivery systems. Instructors planning to teach via video conference participate in a video conference workshop. The focus of this workshop is on the course presentation by that particular delivery system. The faculty gain expertise in using the technology that they will use in teaching while demonstrating and receiving feedback on a specific teaching strategy. Experienced teleconferencing faculty join inexperienced faculty in these workshops to share ideas and expertise.

Individual sessions - These sessions with faculty begin with what is termed a pre-production planning meeting. Topics of discussion begin with the instructor's teaching or learning objectives. They include teaching techniques, any special demonstrations or projects, and media presentation issues. Instructors bring to this meeting the following: the course syllabus, an outline of the first session, and samples of graphics and other visual aids that they plan to use. A followup individual session usually consists of a practice video taping session that takes place in the television classroom. For instructors who will teach via video conferencing, this session simulates a video conference, so that the instructor can view their videotape in compression format. It is imperative in this session that faculty evaluate their videotapes for the presence or absence of immediacy behaviors. For example, they observe whether they maintain eye contact with the camera, or how they encourage or discourage student participation.

Office coordination - The Office of Off-campus Credit Courses, in the School of Extended Studies and Public Service, provides coordination and assistance to each faculty member. These services include scheduling, providing course sites with all the necessary course information and supplies, publicity, registration, and media personnel. While the significance of office procedures may not be readily apparent, a timely response to instructors' and students' requests is imperative to the smooth functioning of a course.

Evaluations - Evaluations occur in each course. The instructional designer conducts live formative evaluations approximately one-third of the way through the course. The purpose of the formative evaluations is to detect any problems associated with the delivery of the course, so that the problems can be addressed. In video conference classes the formative evaluation is conducted over the video conference system. Instructors receive a typed transcription of their students' discussion. These evaluations provide the students with an opportunity to look critically at the course as a whole and offer relevant suggestions. At the University of Wyoming the instructional designer asks these three questions:

1. What do you like about the course so far this semester?
2. What don't you like about the course so far this semester?
3. How would you recommend that changes be made?

Summative evaluations are administered in written form at the end of the course. Students address demographic issues followed by questions related to aspects of learning, the technology, interaction, satisfaction, and future recommendations about such courses.

In general, an instructional designer at the University of Wyoming monitors the progress of a course by remaining in contact with the producer/directors, academic coordinators, site facilitators, students, and certainly the instructors. Instructional designers at the University of Wyoming begin with the assumption that everyone wants to be a good teacher, with the result that distance teaching faculty typically improve their teaching and teaching evaluations. Standard faculty development strategies at the University of Wyoming (Farr, Murphy, & Flatt, 1992) include the following:

- Videotape practice sessions
- Encourage mentoring
- Brainstorm ideas
- Accentuate the positive
- Enable faculty to work with groups from the same discipline
- Help faculty think from students' perspective
- Provide "resources" not available on campus

- Save the instructor's time
- Offer opportunities for research
- Conduct formative as well as summative evaluations

Summary

Faculty development provides the opportunity for distance education instructors to learn to exploit the attributes of video conference technologies and to practice using the technology. From instructional designers the instructors also learn ways to incorporate communication behaviors in their teaching that will increase social presence while reducing the learners' sense of physical and psychological distance. Some immediacy teaching behaviors that have been used effectively in video conferencing contexts follow.

- Provide telephone office hours
- Provide written comments to students on assignments/exams
- Use personal examples
- Use "we"
- Smile
- Maintain relaxed body posture
- Use hand gestures
- Lean toward camera
- Maintain eye contact with the camera
- Use a variety of vocal expressions
- Use humor
- Encourage participation
- Ask questions
- Ask students their feelings about assignments, deadlines, or discussion topics

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Title:

Criticizing Instructional Materials Evaluation: Adding Meaningful Dimension

Authors:

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747

Criticizing Instructional Materials Evaluation: Adding Meaningful Dimension

Overview

Critical evaluation of instructional materials is an important but often neglected aspect of instructional preparation. Teachers do not usually select their instructional materials (in whatever the format) according to formal, generalized, research-based prescriptions for doing so. And only rarely do teachers consider criteria beyond those which are achievement and technically oriented (Rothe, 1991). Instead, we are likely to develop and use our personal, situated routines to select and evaluate materials. This study suggests evaluation that is more theoretically grounded in socio-cultural and local, context-sensitive bases than are many current selection/evaluation guides. It reviews the development of evaluation tools, provides new measures, and applies new measures to current visual materials. A new evaluation instrument was developed and applied to materials for teacher education. From preliminary research in this area, we expect the interpretation to reveal a number of explicit and implicit ideological stereotypes and assumptions about our beliefs about teachers, teaching, classrooms, and mediated education. We believe as our project continues that examining this visual material will provide new understanding of our field and our educational beliefs.

Background and Rationale

Evaluation of materials has traditionally been derived from behavioral theory and the systematic design of instruction so basic to our field. Within these theories, learning is conceived narrowly as the learning objectives and the methods used to get students to achieve those objectives. The limitations of these theories as a basis for evaluation or selection of materials have been repeatedly pointed out by current critics of educational technology. Bowers (1988) discusses the "current blindness" of the "conduit" view of software evaluation, for example (p. 47). Bowers goes on to critique the instructional procedures of an evaluation model based upon Gagne's events of instruction. He points out that such a model ignores the subjectivity of language and the awareness of the influence of language on thought. This is just one example of criticism which points out the severe limitations of our current evaluation models.

The field of educational communications needs to revisit our theoretical basis for the simple models of evaluation or selection which we have been using for so long. Kerr (1985) has suggested that methods drawn from sociology, policy sciences, and anthropology could "shed new light on problems that have traditionally been approached using psychological research methods" (p. 4) Kerr believed that asking new questions in less traditional ways was critical to the future of education. With more multi-cultural and critical dimensions of education becoming a reality, the area of materials evaluation and selection and the messages being given to teachers need to be re-examined.

Eisner (Eisner and Peshkin, 1990) suggests new methods, and comments on the limitations of old models. "The methods into which we have been socialized provide powerful filters through which we view the world. If we are predisposed to focus upon the unique features of a person or situation and skilled in their literary description, we are likely to attend to classrooms in ways that emphasize or make salient the idiosyncratic. If we are inclined toward the description of measured relationships or the incidence of events, if what we are inclined to think about is how things co-vary, we see the "same" classroom from a very different angle and with a very different intent. In short, our methodological concepts influence our perception. Thereafter, cognitive maps help us find our way in the territories we wish to explore. Those with different maps tend to take different roads." (p. 9) Eisner points out that our methods create filters on our perceptions.

Yeaman (1991) discusses the importance of the socio-cultural aspects of our field, which he calls neglected. "Educational communications and technology research concentrates on the efficiency of learning stimuli, instructional techniques and matching these with student characteristics." (p. 990)

And Ellsworth (Ellsworth and Whatley, 1990) has commented that: "Such research privileges questions of how individuals process information from educational media over and above questions about the ideological work of meaning construction, content selection, setting of objectives, and media use. The concept of information processing as developed within cognitive psychology and applied in educational technology cannot explain meaning, intent and significance." (p. 49)

An examination of evaluation from a socio-cultural viewpoint begins to provide more powerful and meaningful dimensions in the evaluation of media materials, historical or cutting edge. This project begins to integrate media criticism and post-structuralism as a basis for improved evaluation, and provides a sample application. The application involves visual materials for teacher education: film, video and multi-media.

Teachers have conceptual and attitudinal knowledge of technology based on their experience and the methods and materials used to teach them about the technology. These materials remain largely unexplored from both an aesthetic and a critical or formal perspective. Likewise, only recently have a few scholars turned their critical attention to educational films and videos in order to explain their messages, overt and otherwise. The visual representations and the actual construction of knowledge in these materials are now beginning to be investigated. Ellsworth's (Ellsworth and Whatley, 1990) research is an example of such work and is used to guide the work presented here.

In their text, *The Ideology of Images in Educational Media*, (1990), Ellsworth and Whatley discuss this recent move to examine the ideology of images. They point out that until very recently, educational communications research was still focused on effectiveness and on how learners gain from mediated messages. Recently, educational media researchers have turned their attention to educational films and other materials, and are investigating the visual representations and the actual construction of knowledge. Ellsworth's study cites examples of research examining science and health films and print materials.

The aim of this multi-phase project is to suggest substantial changes in the ways teachers evaluate curricular materials for teaching; to begin an historical record of our field in terms of film and video; and to bring a more grounded and broadly literate understanding of instructional materials to both theorists and practitioners.

The results will be summarized and examined for the messages we can discover involving materials, teachers, pedagogy, and technology. In addition, this work will focus on the hidden curriculum of such messages, describe what was considered valid knowledge, and determine who possessed it. Our educational culture will be described, and new ways of looking at educational media will be explored. In completing this project we will produce a brief history of the teaching of media utilization and evaluation, test a new evaluation tool, and analyze several mediated materials.

Analyzing Materials

The presentation itself was an introduction to postmodernism and its emergence as an important viewpoint for educators (see Suggested Reading List), followed by an evaluation activity. Questions raised by a postmodern perspective include issues of emancipation, ethical behaviors, and empowerment. In media postmodernism leads us to question who is delegitimized and "othered" by mass media such as television. These same questions were then raised while reviewing a newer educational videotape from a series. A new evaluation form based upon work by Rothe (1991) was shared. This form was prepared using socio-cultural analysis aspects to provide several meaningful new dimensions to the evaluation process (see Instructional Materials Evaluation). Participants were invited to use and critique this new instrument, and comment upon its perspective and its usability. Discussion followed about the process and the viability of socio-cultural evaluation in schools and by teachers. The new form encourages viewers to "see" in a new way; to not ignore important, if subliminal, visual aspects.

This presentation session suggested that typical evaluation forms and models are little used because they are severely restricted in their conceptions of learning. Learning is conceived narrowly as the learning objectives and the methods used to get students to achieve those objectives. Too often, evaluation of instruction and instructional materials does do not fully consider the political, economic, language, contextual, and other cultural influences on learning.

Take, for example, the idea of rule learning. A conventional approach usually asks us to evaluate materials based on whether or not students learned the rules of, say, written English as specified by learning objectives. We want to say that someone has learned something more important when he or she has learned those rules and, additionally, understands a variety of meanings of using the formal rules. A person should know when, in what context, she has the option to use one set of languages rules or another.

These extended understandings of knowing/learning are crucial because they are in realms where many, even most, of the important influences on learning reside. We can select a material based upon what it explicitly teaches and how it explicitly teaches discrete knowledge, but if that learning is politically, ecologically, or economically discouraging to the learner and the learner doesn't get a chance to understand the politics, ecology, or economics, to that extent learning (and teaching?) is a failure. For example, if learning is taught as a predominantly individual and cognitive activity devoid of any emotion or community, other useful ways of knowing are apt to be stunted or dominated for powerful purposes.

Likewise, a teacher with a restricted idea of materials and with restricted materials is less likely to see the changes she or he looks for in the learner, whether those changes are task specific (as we say) or are in more general terms of learner attitudes and strategies toward learning and knowing.

An evaluation form such as the standard one reproduced in most Instructional Technology basic textbooks (ie. Heinich, Molenda, and Russell, 1993) asks teachers to examine materials using a very narrow range of issues about learning and appropriateness. The materials are evaluated for their use with a particular audience, and it is assumed that the only learning which needs to be considered is that of the intended objectives of the material. Such a typical form allows no room for cultural analysis; it does not ask teachers to consider the cultural ramifications of the materials, nor does it imply in any way that those are issues a teacher may want to consider when selecting and using any material for their classroom.

A more involved and extended approach to evaluation is one suggested by Rothe (1991). Questions regarding language, culture, power, and inclusiveness are included in such an approach. While teachers may consider this method more time-consuming, it is actually an approach which helps them plan the use of their materials while previewing them. No instructional materials should be included in classroom use without some discussion of their creation and intent. Teachers need to be encouraged by this evaluation process to include discussions about the use of language, images, and the representation of culture which any materials represent. Newer technologies, especially, can "other" people, continuing to severely limit the meanings of what is learned, and avoid questions of ecological damage done by the creation and use of technology.

Just recommending that teachers reconsider their evaluation of materials is not enough, but it is one simple method by which teachers can be encouraged to gain control over materials selection, production, utilization, and evaluation for themselves and for their students. All participants in the education process need to be encouraged to consider the visual, cultural and media literacy issues often avoided by more traditional evaluation procedures. The ideas presented here could be a basis upon which to build a more informed and involved group activity, seeking support for inclusion of the political, economic and cultural issues within the educational milieu.

Copies of handouts are included after the references so that readers may participate further in the ideas suggested by this research. This research project, as it continues, hopes to establish new criteria for the examination and use of visual materials. Teacher educators and teachers will promote a more visually literate audience with these activities. Evaluation of materials becomes one method by which to encourage a reexamination of teaching and learning from a more inclusive cultural dimension.

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Instructional Materials Evaluation

Title: ______________________________

Source, Date, Length, Cost: ______________________________

Subject Area/Audience: ______________________________

Brief Description/Subject Matter: ______________________________

____

Language Usage	Does Not Apply	Not at All Poor	Somewhat	Completely Well
1. Is the language used context specific?				
2. Will students understand the concepts presented, especially those presented within metaphors using familiar words in new ways?				
3. Is one point of view presented without the acknowledgement of other possibilities?				
4. Is the language used appropriate to the content but broad enough to allow other points of view?				
Comments:				
Perspectives				
5. Is the framework for content selection explained?				
6. Is the design of the information obvious? Are designers' choices explained?				
7. Does the knowledge presented allow flexibility for student and teacher involvement?				
8. Is this material marketed in an easily usable and available format?				
9. Is material designed to reflect mainstream society's assumptions concerning relevant cultural features such as responsibility, education, career, family, religion, etc.?				

Perspectives Cont.	Does Not Apply	Not at All Poor	Some-What	Completely Well
10. Does the material promote and reflect the distinctive character and values of all cultures?				
11. Is this material directed to the largest number of users to the exclusion of minority or smaller groups within the educational population?				
12. Is the value framework for this material evident?				
13. Are the students or teachers given the opportunity to question or explore the values framework used?				
14. Do the values presented interface with the values held by users?				
Comments:				
Curricular/Strategy Issues				
15. Is this material promoting effective and efficient learning to the exclusion of more broadly-based learning outcomes?				
16. Is the underlying message of this material that technologically driven learning is preferred over other types of learning?				
17. Is the material appropriate educationally rather than selected as a result of some commercial effort?				
18. Is using this material the soundest solution to the educational problem involved?				
Comments:				

Derived from Rothe, J. P. (1991). Critical evaluation of educational software from a social perspective: Uncovering some hidden assumptions. In Hlynka, D. and Belland, J. (eds). *Paradigms Regained*, New Jersey: Educational Technology Press, pp. 367-384.

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Title:

The Design of Effective Case Study-Related Learning Strategies Training

Author:

Alice E. Nuttall

THE DESIGN OF EFFECTIVE CASE STUDY-RELATED LEARNING STRATEGIES TRAINING

by Alice E. Nuttall

Introduction

The purpose of this paper is to: (a) describe how case study training materials were developed for an experimental research study, and (b) discuss effects of such training.

Because the research study (Nuttall, 1991) examined the effects of task-related learning strategies training on performance and motivation in a case study task, it was necessary to develop both general case guidelines and learning strategy guidelines.

The Need for Learning Strategies Training

A dearth of experimental studies on achievement and motivational outcomes of training in self-regulated learning strategies suggests a need for research in this area. As stated by Dansereau (1985),

> ...at this point systematic learning strategy research is still in its infancy. Consequently, it is impossible to derive a solid set of principles that can be used to plan and conduct future studies (p. 218).

One needed research area is the domain-general vs. domain-specific training question. For example, Mayer (1988) and Miles (1988) recommend the pursuance of domain-general or content-independent research, while Dansereau (1985) and Cook (1982, cited in Mayer, 1988) are pursuing domain-specific or content-dependent learning strategies training.

Researchers (i.e., DuBois & Kiewra, 1989) also recommend studying combinations of at least two or three strategies in a domain- (subject-or content-) based situation where individual outcomes can be assessed. Along that line, DuBois (1988) and Mayer (1988) recommend the study of which strategies make a difference and why. Furthermore, Mayer (1988), McKeachie (1988), and Weinstein et al. (1988) suggest that connections between student motivation and learning strategies skill be studied. As DuBois (1988) notes, "It is not enough to analyze GPA changes" (p. 17).

Among other needed research are: (a) classroom application studies (Doyle, 1986; Good & Tom, 1985; Martin & Briggs, 1986, Reigeluth, 1983) and (b) the study of affective domain/motivation outcomes (Briggs, 1982; Corno & Mandinach, 1983; Martin & Briggs, 1986; Reigeluth, 1983).

Learning Strategies Theory and Research Design

A theoretical framework of outcomes and influences of task-related learning strategy training appears in Figure 1. A diagram of the research design used to assess outcomes of learning strategy training appears in Figure 2.

The theoretical foundation for learning strategies training was a social-cognitive/expectancy-value model of college learning and teaching developed by McKeachie, Pintrich, Lin, and Smith (1986). This model hypothesized that: (a) student motivation and learning strategies knowledge not only affect each other but lead to both engagement in learning and academic performance; and (b) individual student characteristics may influence task-related motivation and academic performance.

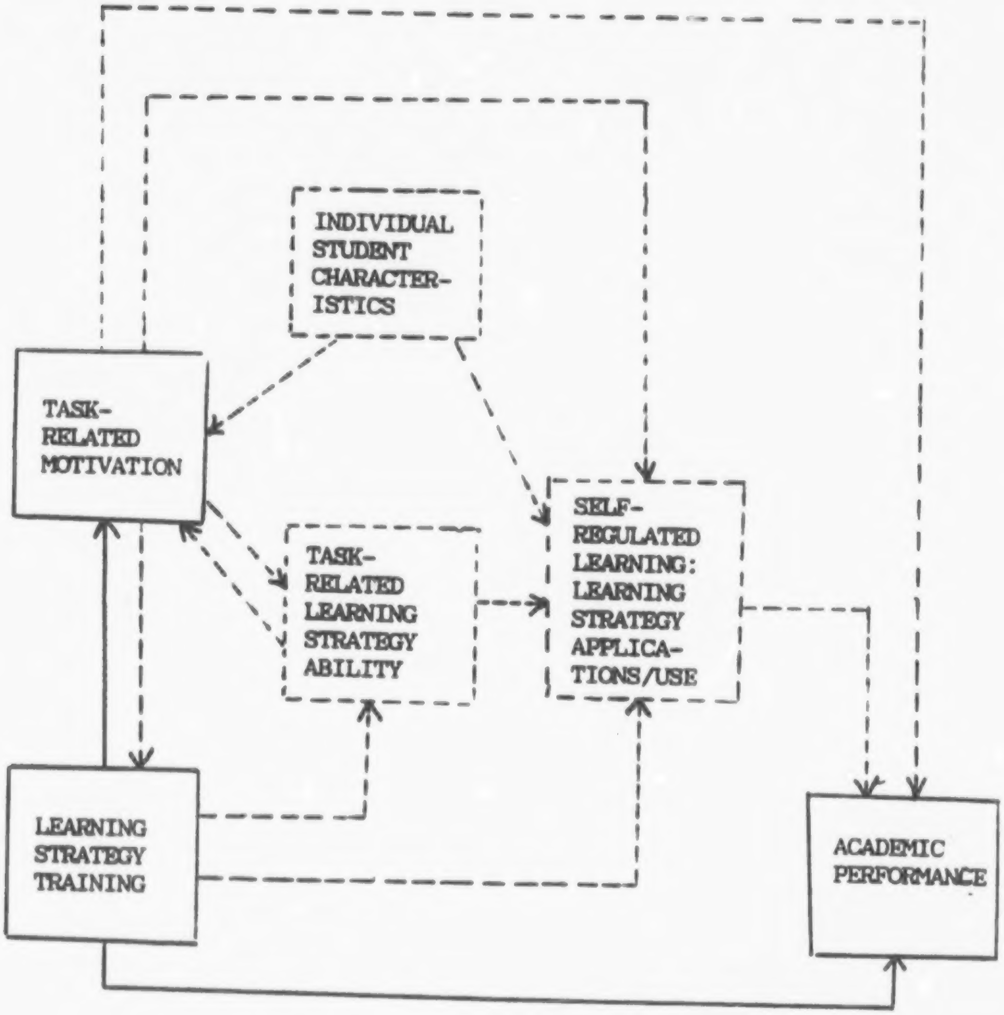
In a posttest-only, two-group experimental design, Associate Degree introduction to management students in a comprehensive state university were given a short business management case or "incident" along with background information describing management's primary functions (planning, organizing, directing, and controlling) and processes (decision making and communication). During four 75-minute sessions over two weeks, 54 subjects were asked to complete three tasks: (a) list symptoms indicating that problem(s) existed; (b) categorize symptoms as appropriate function and/or process; and (c) state problem(s).

Both groups, control and experimental treatment, received training in how to analyze a business case study: in addition, the treatment group received task-related training in learning strategies and tactics.

Assessments were made for three performance outcomes (the tasks listed above) and three task-related motivational outcomes: (a) perceived task-related self-efficacy for learning; (b) expectations for task-specific academic success, and (c) desire to continue learning more about management in general as well as case study analysis in particular. In addition, relationships were examined between 22 individual characteristics, experimental outcomes, learning strategy use, and learning strategy value.

Since motivation is, by definition, consciously or unconsciously decided goal-directed behavior, task-related goal orientation and self-concept motivation variables were emphasized. Expectancy for success indicated the extent to which subjects felt they would obtain high scores on business case problem

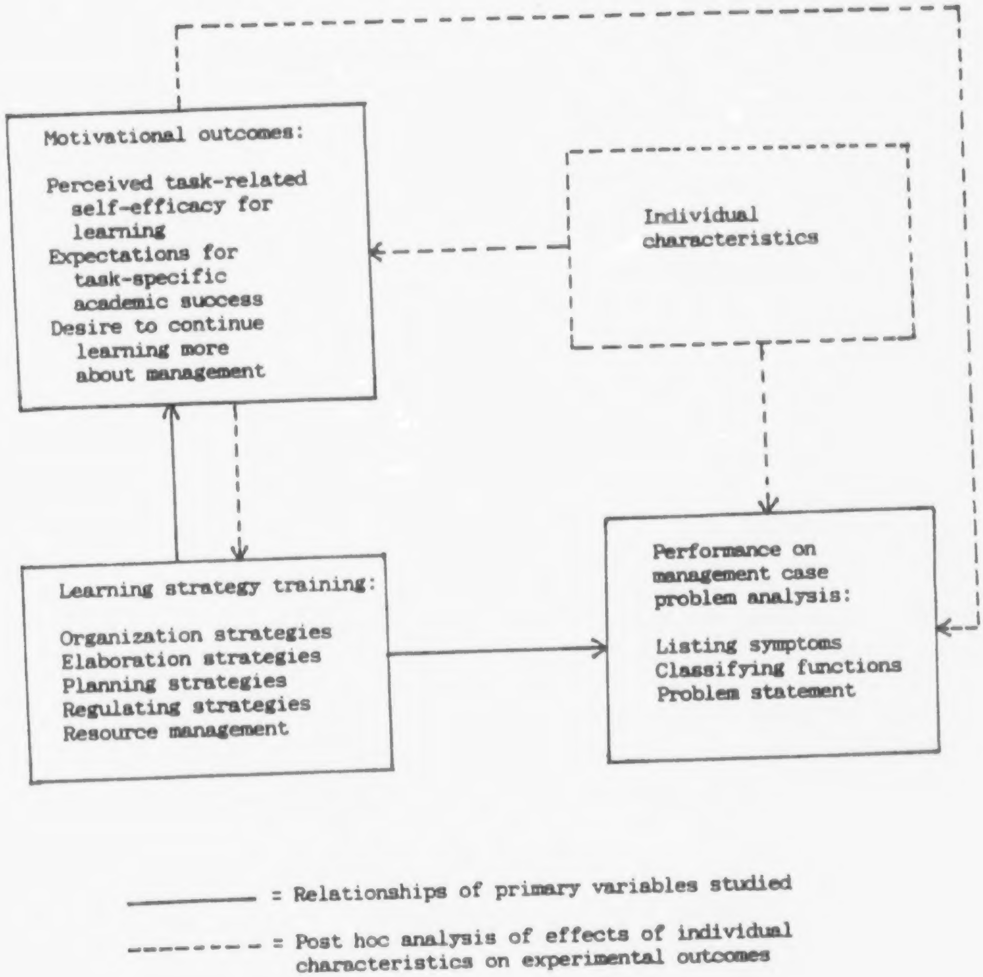
Figure 1. Outcomes and influences of task-related learning strategy training: A theoretical framework


INDIVIDUAL STUDENT CHARACTER- ISTICS
TASK- RELATED MOTIVATION
TASK- RELATED LEARNING STRATEGY ABILITY
SELF- REGULATED LEARNING: LEARNING STRATEGY APPLICA- TIONS/USE
LEARNING STRATEGY TRAINING
ACADEMIC PERFORMANCE

——————— = Relationships of variables studied

- - - - - - - - = Theoretical explanation of relationships with other variables

Figure 2. Outcomes and influences of task-related learning strategy training: Experimental variables


Motivational outcomes:
Perceived task-related self-efficacy for learning
Expectations for task-specific academic success
Desire to continue learning more about management
Individual characteristics
Learning strategy training:
Organization strategies
Elaboration strategies
Planning strategies
Regulating strategies
Resource management
Performance on management case problem analysis:
Listing symptoms
Classifying functions
Problem statement
= Relationships of primary variables studied
= Post hoc analysis of effects of individual characteristics on experimental outcomes

tasks. Self-efficacy for learning components included understanding difficult written or oral information presented, learning basic concepts, mastering skills being taught, and confidence in completing assignments and tests involved in a case problem project.

Instructional Materials

Instructions for the experimental group, Research Group T, appear in Appendix A. Other materials used included: Guidelines for Case Analysis (Appendix B), including an example case (Appendix C); and Learning Strategies and Hints for Case Analysis (See two-page excerpt in Appendix D).

A six-page "Supplement to Learning Strategies and Hints for Case Analysis," illustrating examples of learning strategies applications, was also provided all the experimental subjects; this is available, by request, from the research investigator. All materials, as well as the documentation of their development, are also included in Nuttall (1991).

Instructions and materials that were given only to experimental Group T are noted in all capital letters in Exhibit A, "Instructions," and refer to learning strategies and hints for case analysis, as well as practice worksheets (See Appendix E for the example of a completed worksheet). Both groups received all other materials.

Development of Case Study Guidelines

Cases and instructions for case analysis were derived from a combination of published textbooks (Albert, 1988; Baack, 1988; Dietzer & Shilliff, 1977; Edge & Coleman, 1982; Jauch, Coltrin, & Bedeian, 1989; Schuler & Dalton, 1986; Tavernier, 1988; Wales, Nardi, & Stager, 1986) and the research investigator's experience teaching a course entitled Case Studies in Business Management Technology.

Development of Learning Strategies Training

Learning strategies training was based on strategies that were not only applicable to the task but were also strategies indicated as correlating with performance and such self-concept related motivation dimensions as self-efficacy and expectancy for success (See Eison et al., 1986; Pintrich, 1986, 1987; Pintrich & De Groot, 1988; Schutz et al, 1989).

The task was considered by experts to be one that required identifying important points, classifying information, and stating problems. Ability to read and handle a sheaf of written instructions and references was also needed.

Using definitions and instruments developed by Pintrich et al. (1988), as well as information processing or knowledge patterns described by DuBois and Kiewra (1989), a pilot study provided lists of useful task-related learning strategies and tactics as well as an assessment of the relationship to academic performance and motivation of four categories of strategies: organizing, elaborating, planning, and regulating.

The assessment of "other" strategies involved the reported use and value of twelve individual study techniques, rather than the use of composite groups of strategies described below, and included selected resource management strategies.

Organization strategies. Organization strategies included: (a) identifying important points in readings and notes; (b) outlining reading; (c) outlining notes; and (d) making simple charts, diagrams, or tables.

Elaboration strategies. Elaboration strategies included: (a) pulling together information from different sources (i.e., lectures, handout information, readings and discussion); (b) making connections between readings and concepts from lecture; (c) relating case to what student know; (d) writing brief summaries of main idea of case; (e) applying ideas to cases from other class activities (i.e., lecture and discussion); and (f) relating ideas from case studies to other courses.

Planning strategies. Planning strategies included: (a) before studying thoroughly, skimming reading material to see how it's organized; (b) making up questions about case; (c) setting goals for each period of study activities; and (d) thinking through topic of case problem rather than just reading it.

Regulating strategies. Regulating strategies included: (a) rereading when confused; (b) when difficult readings encountered, changing the way material is read; (c) adapting learning/studying style to instructor's requirements and style; and (d) when confused about notes or instructions, sorting out ideas or doing something about it.

Other strategies. Other strategies included: (a) having all materials organized before beginning task (organizing); (b) timing work (resource management); (c) asking others for help (resource management); (d) reading the case more than once (regulating); (e) underlining or highlighting important points (organizing); (f) writing notes in the margin of the case (organizing); (g) taking written notes about the case (organizing); (h) making a diagram of the case facts (organizing); (i) using a worksheet to organize symptoms (organizing); (j) writing a rough draft of problem statement (organizing); (k) concentrating in a quiet place (resource management); and (l) referring frequently to instructions and other materials.

Application of strategies in instructional materials. Most of the above-listed strategies were at least mentioned in the instructional materials, although extensive training was not provided. Strategies not mentioned or not readily evident in the materials included: (a) outlining reading and notes; (b) applying ideas to cases from other class activities; (c) setting goals for each period of study activities; (d) adapting learning/studying style to instructor's requirements and style; and (e) concentrating in a quiet place.

Discussion of Results

The treatment resulted in significant performance increases in two tasks: (a) listing symptoms of case problem(s), and (b) labelling symptoms according to management function or process. These outcomes were viewed as possible evidence that the learning strategies treatment had had at least some effect on outcomes.

There was no significant increase for a third task, writing a problem statement. However, both groups performed better on the problem task than the other two tasks. Possible reasons for these results included: (a) Since there were no significant correlations between problem and either symptoms or functions tasks, perhaps different strategies were needed to write a problem statement; (b) the case study guidelines may have served as a "megastrategy" that gave both groups equal training in solving a problem task.

In assessing learning strategy use, two tactics were used by the treatment group significantly more than the control group: (a) referring frequently to instructions and other material, and (b) reading the case more than once.

In addition, post hoc analyses indicated differences between internal workings of the groups in unique correlations between learning strategies use, learning strategies value, self-concept related motivational variables (i.e., task-related self-efficacy and expectancy for success), performance, and individual characteristics.

Specifically, results confirmed the dynamism of continuing intrinsic motivation, which has been defined by McCombs (1984) as:

> a dynamic, internally mediated set of metacognitive, cognitive, and affective processes (including expectations, attitudes, and beliefs about the self and the learning environment) that can influence a student's tendency

> to approach, engage in, expend effort in, and persist in learning tasks on a continuing, self-directed basis (p. 200).

The study also confirmed that self-efficacy is a major recurring motivational factor (See Bandura, 1986; Covington & Omelich, 1987; McCombs, 1986; Schunk, 1986.

In addition, results suggested that learning strategies training can affect associations between variables related to performance and motivation, thus indirectly affecting performance (See Eison et al., 1986; McCombs, 1984, 1987; Pintrich, 1986, 1987; Pintrich & De Groot, 1988; Schutz et al., 1989), especially in the area of individual characteristics such as personal beliefs about the importance and value of both task and learning strategies.

Conclusions

Two conclusions are evident. First, task-related learning strategy training is a viable method for increasing academic performance.

Secondly, instead of directly affecting self-concept related motivation (especially in the areas of self-efficacy and expectancy for success), task-related learning strategy training may affect synergistic interactions between learning strategy use and value, performance, motivation, and individual characteristics.

Implications for Practice

Implications for practice include integrating into all instructional plans the following: knowledge of subject content, learning strategies, and attributions awareness (knowledge of how individual characteristics and motivation may affect learning).

Regarding motivational variables studied, it is recommended that self-efficacy and expectancy for success continue to be studied within the self-concept context. Desire to learn is a more complex variable in that it incorporates more than the self-concept context.

In addition, in conducting research in this area, two limitations of the current study should be addressed: use of self-report instruments and time period.

Regarding instrumentation, subjects need to be tested as to their actual knowledge and application of learning strategies.

Regarding time, adequate time--i.e., a minimum of three to six months--must be allowed for appropriate practice, mastery, and motivation for actual use of learning strategies. In pilot studies, which took place over longer periods of time (up to two and one-half months), subjects enrolled in a case studies course showed significant gains in planning, self-efficacy, and expectancy for success. This type of long-term, classroom applications, research must be expanded.

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APPENDIX A

INSTRUCTIONS FOR CASE TRAINING SESSIONS - RESEARCH GROUP T

Your task is to analyze business management cases. Starting today, you will work on one case during each of the next three class periods. During the fourth class period you will complete a "test case" and a questionnaire. You will not be asked to recommend solutions. Instead, you will concentrate on identifying the problem(s) that exist in the case. To do this, you will:

(1) List symptoms of the problem(s), which are facts that indicate something is wrong.

(2) Label each symptom as one of the six management functions and processes described in the attached "Management Functions and Processes Review Sheet" (Planning, Organizing, Directing, Controlling, Communication, and/or Decision Making).

(3) Write a problem statement in sentence/paragraph format. This is a statement of what is wrong in the case and explains, in approximately one to five sentences (a paragraph), the main cause(s) of the symptoms of discontent previously listed. There may be more than one problem and, because you may have incomplete information, you may have to make some assumptions (and guesses!) in deciding what are symptoms and what are problems.

(4) BEFORE YOU WRITE YOUR PROBLEM STATEMENT, COMPLETE THE WORKSHEET ENTITLED "ORGANIZATION OF SYMPTOMS BY FUNCTION/PROCESS" (THREE BLANK COPIES ARE ATTACHED FOR YOUR USE).

More detailed instructions, including information about how to distinguish between symptoms and problems, appear in the attached documents entitled "Guidelines for Case Problem Analysis" and "LEARNING STRATEGIES AND HINTS FOR CASE ANALYSIS." NOTE, IN PARTICULAR, LEARNING STRATEGY EXAMPLE 5 FOR GUIDANCE IN COMPLETING STEP 4 ABOVE.

Completing Your Work. You may start working on your case as soon as you have read all the instructions and guidelines. After you have completed the answer sheet attached to each case, as well as the worksheet, you may obtain copies of both Answer Keys from your instructor. Compare your responses with the responses on the Answer Keys to determine how you can do better on the next case.

(Continued on next page)

Instructions for Case Training Sessions, Research Group, Page 2

Other Procedures. While you are involved in this project, please do not talk to anyone about the cases--before, during, or after class-- and do not share your notes with anyone. This is to insure that everyone has an equal chance at doing well on the cases. Keep these instructions, including the Management Functions and Processes Review Sheet, Guidelines, WORKSHEETS, LEARNING STRATEGIES AND HINTS, and all answer keys, for reference in doing your other case analyses.

Materials to Obtain from Instructor: Case A, Acme Machine Company (for first day); Case B, Management by Rushing Around (for second day); Case C, Conflict on the Plant Floor (for third day); and blank answer sheets and answer keys for each case (one case per class period).

APPENDIX B

GUIDELINES FOR CASE PROBLEM ANALYSIS

Introduction

The cases you will be studying are examples of situations experienced in the business world. Something has happened that has caused one or more problems, and management must decide what to do to improve the situation. In order to recommend solutions to any problem, however, management must determine what the problem is; for without knowing what problem needs to be solved, any recommended solutions would be merely guesses.

As Gerald Tavernier, a management consultant has noted, more and more companies are realizing that the cost of trying to solve the wrong problems can be very high, and many companies have started formal training programs for managers on problem solving, "with particular emphasis on problem identification."

One example of poor problem identification is the situation where a company thought its problem was high inventory, when actually the inventory was uneven; the stock levels for factory supplies of each item were wrong, causing production to get behind schedule, even though there were surpluses of some materials. Another example was a West German firm that blamed its drop in exports on the high value of its country's currency, when the real cause was faulty engineering and a failure to meet market demand.

Guidelines about how to complete your cases problem instructions appear below. The attached case "No Business Like Snow Business" will be used as an overall case example. Refer to the answer key attached to these guidelines for examples of correctly stated symptoms, functions, and problem.

1. Listing Symptoms

Symptoms are evidence that a problem exists. List all facts that indicate that something is wrong or where a situation exists that could be improved. Be very specific in noting unusual behavior, conflicts, or changes. For example, instead of stating "poor morale," state that "employees were refusing to do their work or breaking the machinery." You will determine later whether or not this behavior was caused by poor morale or something else.

In addition, don't make value judgments yet; just describe what happened. Don't just say, "He didn't communicate well." Instead, list specific behavior

772

Guidelines for Case Problem Analysis (Page 2)

you observed that led you to this conclusion--i.e., "there was not much eye contact, the person's voice sounded harsh, the person fidgeted in his seat, folded his arms, looked away and sighed, interrupted others when they were talking, etc."

Also separate important facts from unessential facts. In the "Snow Business" case, information in the second paragraph about the SBA consultant was background information to set a general scenario and was not essential to the identification of case problems.

Finally, be alert to case terminology where symptoms may be called problems. For instance, in the "Snow Business" case, the last paragraph states, "The firm's questions and problems centered around the only cash register..." Here, the cash register was a symptom of a problem, not the problem itself. The root problems were planning and directing, as related to the cash register. Controlling was not a root problem because it was caused by something else--i.e., poor policies and procedures (planning functions).

2. Label Symptoms According to Management Function or Process

Now that you have a list of symptoms indicating that one or more problems exist, label each of these symptoms as one of the following six functions or processes of management: Planning, Organizing, Directing, Controlling, Communication, and Decision Making. These are described in your review sheet. This process will help pinpoint the main problem areas in the case. Note: It is possible that one fact could represent more than one management function or process. Before assigning more than one function, however, break down facts into smaller units if possible.

3. Write Problem Statement

The problem statement explains the main cause(s) of symptoms of discontent previously listed. Approximately one to five sentences (a paragraph) should be adequate to tell management what is wrong in a situation and what needs to be corrected. Concentrate on the major functions and processes of management you used to classify/label your symptoms.

As advice in writing your problem statement, note that: (a) Since symptoms may have many causes, there may be more than more problem; and (b) the problems you list should be significant ones. In the "Snow Business" case, for example, the shortages

Guidelines for Case Problem Analysis (Page 3)

in the cash register could have been due to at least two different problems: (1) Lack of appropriate policy and procedures (a planning problem) and (2) Lack of appropriate controls over the disbursement of monies (a controlling problem). In this case, lack of appropriate controls was caused by lack of appropriate policy and procedures, which makes planning the significant problem area.

In determining whether a problem is significant, ask yourself how many symptoms can be explained by it. The more symptoms a problem can explain, the more significant it is. In case study analysis, the most significant problems are called major problems, while less significant problems are called minor problems. For the purposes of your task, you will concentrate on major problems.

Distinguishing between Symptoms and Problems

A problem exists when there is a gap between an existing condition and a desired situation. Symptoms are the facts showing that something is wrong--that a problem exists. In identifying a problem, you might pretend that you are a detective looking for clues that something is wrong, in which case these clues would be symptoms of a problem.

Once you have identified the symptoms, you then make guesses on what caused them, since the cause of the symptoms is the problem. For example, a patient tells a doctor he has a high temperature and headache (a symptom), but the problem that is causing the headache could vary from a mild case of flu to a severe case of brain infection.

Examples of symptoms of business problems that you might be familiar with include high absenteeism, tardiness, and complaints about the work environment. Depending on other facts in a particular case and assumptions you make, the problem could be related to poor communication, bad leadership, inadequate policy or planning, inefficient organization of the work station, low pay, unfair standards of performance, etc.

3/19/90
Alice E. Nuttall
Kent State University

MANAGEMENT FUNCTIONS AND PROCESSES REVIEW SHEET

Management Functions

PLANNING - Determines what needs to be accomplished and determines how and when it will be done; anticipates needs in establishing goals, objectives, policy, procedures, budgets, and schedules.

ORGANIZING - Arranges and coordinates resources so that objectives can be met; effectively organizes staff, materials and equipment, methods, procedures, and financial resources to meet organization's objectives.
Sets up organizational structure and chain of command.

DIRECTING - Through leadership and delegation skills, provides guidance to subordinates so they can accomplish their assigned work. Also recognizes individual differences in people and points of view and creates a motivational atmosphere that will build employee morale.

In the area of leadership, elicits enthusiastic cooperation and creative initiative from both subordinates and associates. Applies appropriate style of leadership to given situation; knows when to be directive and when to be a participative manager, whether in a small or large business organization.

In the area of delegation, delegates responsibilities as appropriate and effectively utilizes subordinates' skills. Knows how to clearly define and follow up on delegated responsibilities to the degree that subordinates carry out assignments even when not under constant supervision.

In carrying out management functions, knows how to make quantitative applications and consider both behavioral dimensions and environmental conditions of a given situation. Is responsible for organization's financial situation.

CONTROLLING - Appropriately measures results against established objectives and standards (i.e., quantity, quality, timeliness, and cost); monitors desired performance against objectives for both self and subordinates, and corrects procedures and performance as necessary.

Processes Used to Perform Management Functions

COMMUNICATION - Demonstrates effective writing, speaking, and listening skills in communicating with all levels of employees. Is sensitive to the role

(Continued on next page)

Management Functions and Processes Review Sheet, Page 2

personal values and attitudes, and other personal characteristics play in interpersonal interactions.

DECISION MAKING - In solving problems and making decisions, shows discretion and arrives at sound common sense decisions. Uses both fact and intuition-based problem solving strategies; demonstrates logical, clear, and consistent thought, as well as ability to generalize what is learned from one situation to another.

2/18/90
Alice Nuttall
Kent State University

APPENDIX C

EXAMPLE CASE: NO BUSINESS LIKE SNOW BUSINESS

Bill and Janet Schneeman are co-owners of the Olympic Ski Haus, a new and small sporting goods store that specializes in ski and tennis equipment along with apparel accessories for both these sports. During the stages of incorporation, the Schneemans applied for a Small Business Administration loan of $50,000. As a condition of receiving the loan, Olympic Ski Haus agreed to the services of an SBA consultant--a retired business executive with retailing experience.

During his investigative interview, the SBA consultant discovered, among other things, that when Bill and Janet incorporated the business, both agreed there would be no boss. "We share authority and responsibility equally here," they told the consultant.

Furthermore, they advised him that in the interests of equality, it was agreed that each party could independently make decisions and set policies for the management of the store. Each could give orders and instructions to the store's

(Continued on next page)

Appendix C, Example Case: No Business Like Snow Business, Page 2

two employees with the mutual understanding that, if any employee had questions or problems, he or she could appeal to either owner for help or advice.

"We are too small an outfit to be concerned about such things as objectives and policies here at Olympic. 'No business like snow business' is our store's objective. We take each day as it comes and try to increase our business volume.

"As for policies, we handle each situation as it develops--because each is different--and whoever is here will decide then and there what to do. If the hired help would get different answers or advice, it wouldn't really matter since we're so small. Right Janet?

"As for any market research to determine what our store potential is in this trading area, that's for big firms. We have neither the time nor the help to do this."'

The SBA consultant discovered that many of the firm's questions and problems centered around the only cash register at Olympic. Both Bill and Janet take cash from the register to cover incidental expenses, including meals and beverages consumed during store hours. At the close of day either one present will count and balance the cash receipts against the register totals. Inevitably the cash register is short, and each day the sales clerks are notified of the shortage amount. Consequently, the consultant observed that the clerks feel mistrusted and hesitate to operate the register for fear of being accused of either theft or an inaccurate sales transaction. As a result, both employee sales and motivation seem low.

Source: Bernard A. Deitzer and Karl A. Shilliff. Contemporary Management Incidents. Columbus, OH: Grid, Inc. (1977), pp. 20-21. Copyright by Bernard A. Deitzer. Used by permission.

ANSWER KEY
EXAMPLE CASE: NO BUSINESS LIKE SNOW BUSINESS
(One point for each of 12 symptoms and 12 functions)

A. Symptoms	B. Management Function/Process
1. No one boss; shared authority (Don't know who to listen to; no leadership)	Organizing (Also accept: Organizing and Directing)
2. Shared responsibility (No boss; each gives orders)	Directing
3. Independent or inadequate policy making	Planning
4. Independent decision making (Situational individual decision making)	Decision Making
5. No objectives/goals (Day-to-day outlook)	Planning
6. No policies/procedures/ rules (Day-to-day outlook)	Planning
7. No makert planning/research (Research alone = 1/2 pt.)	Planning
8. Shortages in cash register	Controlling
9. Clerks feel mistrusted (Won't operate register)	Directing (Also accept: Directing and Communicating)
10. Low employee sales (Low morale and confidence) confidence)	Directing (Also accept: Directing and Communicating)
11. Low employee motivation	Directing (Also accept: Directing and Communicating)
12. Both owners take cash from drawer and balance (inaccuarate accounting cash)	Controlling

Example Answer Key
No Business Like Snow Business
Page 2

C. Problem Statement (6 points)

There is a need for better directing and planning. Specifically, management lacks: (1) clear, unified authority (a directing function); (2) clear plans and objectives (a planning function); and (3) policies or standards for operation that all employees can adhere to on an equal basis (both planning and directing functions). These policies and standards will provide controls needed.

3 KEY POINTS (2 points each):

1. DIRECTING (LEADERSHIP AND COMMUNICATION WITH EMPLOYEES)
2. CLEAR, UNIFIED AUTHORITY (FORMAL MANAGEMENT STRUCTURE/ORGANIZATION)
3. PLANNNING/PLANS: OBJECTIVES OR GOALS; POLICIES, STANDARDS, AND CONTROLS

NOTES:

--Give only one point for two symptoms listed together.

--Give partial credit when more than one function is listed.

--No points are subtracted for wrong answers.

3/19/90

Key developed 12/31/89 via input from R. Davis, R. Nay, R. Peterson, H. Tritt, & E. Villella (60% agreement required).

Final revisions and decisions about unclear items on key made in unanimous agreement by: J. Gailey, H. Tritt, and E. Villella at 1/2/90 meeting chaired by A. Nuttall.

APPENDIX D

LEARNING STRATEGIES AND HINTS FOR CASE ANALYSIS

The learning strategies described herein will help you obtain higher grades on each case task. Examples of these strategies are attached.

1. Plan Your Work

a. Before you begin, be sure you have all your materials and notes together and that you understand the assignment. Assemble all the guidelines and other handout material provided by the instructor, and read all instructions, including this handout on Learning Strategies.

b. Look at the clock to determine how much time you have, but don't hurry through the assignment.

c. If you don't understand any part of the assignment, get help. Use a dictionary and/or ask your teacher.

2. Read Case for Understanding

a. Skim the case by reading quickly without taking notes; this will give you a brief overview of the case.

b. Go back over the case a second or third time, reading carefully and highlighting important points (underline, mark with a light colored thick felt pen, and/or write notes in the margin). SEE EXAMPLE 1.

While you're reading, concentrate on the case facts and keep an open mind. Don't make value judgments--i.e., good, bad, true, untrue, etc.--about evidence, people, organizations, or actions. For example, if you are "pro-union" and management is not accepting union demands in the case, do not let personal feelings affect your thinking. Make sure you consider all possible viewpoints. Later on, you will make judgments about the value or relevance to the case of each of these facts.

c. Take written notes about the facts of the case. Ask yourself who, what, when, where, why, and how questions: Who is involved? What is involved? What happened? When did it happen? Where did it happen? Why did it happen? How frequent, serious, and extensive is it? List key names, dates, events, or exhibits for later reference.
SEE EXAMPLE 2.

Nuttall, Case Study Training, 24

Learning Strategies and Hints, Page 2

Think of the case as a play with actors (the "who"), props (the "what is involved"), action (the "what happened"), scenes ("when and where it happened"), causes ("why did it happen"), and significance of consequences ("how frequent, serious and extensive is it?"). SEE EXAMPLE 3.

d. If the reading is confusing, try going over it again more slowly to understand it.

3. Locating Symptoms

a. Use your notes and highlighting as your main source for locating symptoms so you don't have to waste time by rereading the whole case.

b. To separate symptoms from general case facts, code notes or underlining/highlighting by some method such as circling or using check marks. Example: Use underlining for major symptoms and parentheses for general background information. SEE EXAMPLE 1.

4. Classifying Symptoms according to Management Function or Process

Carefully distinguish among functions and processes by using underlining or highlighting on your Review Sheet to be sure that you understand the definitions of functions and processes.

5. Use a Diagram to Connect Symptoms and Main Events

A rough draft flowchart or "cluster diagram" will help you visualize the connections between symptoms and main events, leading to possible causes of theses symptoms. Simply draw lines and arrows between events that show possible causes and effects. A straight line might indicate a relationship, although not necessarily cause/effect, while an arrow could indicate cause/effect. SEE EXAMPLE 4.

6. Writing the Problem Statement

a. Draw on your own personal work experiences or community activities, work experiences of your friends and family, and similar situations discussed in your business classes.

b. Use your diagram to show the relationships of symptoms and other facts in the case. Ask what's leading to what. What situation/factor is causing most of the other factors? SEE EXAMPLE 4.

Learning Strategies and Hints, Page 3

c. On your Organization of Symptoms by Function/Process Worksheet, list all the symptoms that relate to each category, then count the number of symptoms listed for each function/process. Ask which management functions or processes have the most symptoms listed.
SEE EXAMPLE 5.

d. Try brainstorming; write out your thoughts as they occur, then rewrite later. In your own words, based on your own experiences and your diagram of events (See Example 4), try to explain what the connections between symptoms are. Write a draft of what happened, along with reasons. This is called elaboration. SEF EXAMPLE 6.

e. Rewrite your draft into a brief problem statement (See Answer Key). Using the management functions categories listed in your Worksheet (Example 5), state what the general problems are. Then back up this statement with examples. Say, "These problems are evidenced by...."

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APPENDIX E

EXAMPLE 5

WORKSHEET: ORGANIZATION OF SYMPTOMS BY FUNCTION/PROCESS

PRETEST CASE: NO BUSINESS LIKE SNOW BUSINESS

PLANNING:

1. No objectives or goals (day-to-day outlook)
2. No policies, rules or procedures (day-to-day outlook)
3. No market planning or research

ORGANIZING:

1. Unclear chain of command; two bosses have authority

DIRECTING:

1. No one boss; no unity of command
2. Clerks feel mistrusted and won't operate register
3. Low employee sales
4. Low employee motivation

CONTROLLING:

1. Shortages in cash register
2. Both owners take cash from drawer and balance

DECISION MAKING:

1. Independent, situational decision making by co-owners

COMMUNICATING:

1. Employees don't know which boss to listen to or approach

an, 2/24/90

Nuttall, Case Study Training, 27

Title:

The Effects of Group Computer-Based Instruction and Learning Style on Achievement and Attitude

Authors:

Kay L. Orr
Gayle V. Davidson

The Effects of Group Computer-Based Instruction and Learning Style on Achievement and Attitude

Over the past twenty years, computers have been introduced and used in the classroom in an effort to facilitate the learning process. Matta and Kern (1989) stated that the computer has become an increasingly popular technique [tool] in education. In fact the literature we find a plethora of studies which compare computer-based instruction (CBI) to traditional instruction yielding relatively positive results. Although much has been learned in the comparative research of CBI to traditional instruction, scholars in the past few years have become critical over continuation of comparison research (Clark, 1983; Dalton & Hannafin, 1988). Instead of comparative research, we find scholars who advocate the investigation of instructional design and human factors be considered (Clark, 1985; Bracey, 1988; Robyler, 1985). Jonassen (1988) argues that learning is affected more by instructional design factors than the various types of media (including computers). Studying factors, such as cooperative group learning and learning styles in conjunction with computer-based learning environments, may yield valuable information for instructional designers who develop materials using a variety of delivery systems in a variety of settings for a variety of learners.

Furthermore, instructional design scholars and practitioners often advocate that recognition of individual differences is important. Recognition of the fact that individuals learn differently is critical for designing effective instruction, especially in dynamic environments, such as CBI. As a matter of fact, most instructional design models recommend an analysis of the target population to identify specific characteristics of the learners (Gagne, Briggs, & Wager, 1988; Dick & Carey, 1990). As Carrier and Jonassen (1988) point out, information regarding how to use this information in the design and development process is not so readily available. Thus, instructional design research needs to investigate questions about learners and their characteristics in order to determine what type of instructional delivery is best for which type of learner in what type of environment. How learning styles affect students' acquisition of material and their attitudes toward computer-based instruction has been only minimally researched (although largely discussed) in the literature.

Because individuals learn differently, it is logical to suppose that some would prefer to learn individually while others would prefer to learn in groups. Carrier, Newell, and Lange (1982) found a relationship between preferences for instructional activities and learning style. Their investigation showed that individuals differed in their preferences for group-oriented activities. Some learners preferred methods which lent themselves well to group work, whereas others preferred methods which utilized individual strategies. Since, Carrier, Newell, and Lange's (1982) work only dealt with learner preferences, the next logical question is whether students actually perform better in these preferred learning environments.

Thus, several questions were raised as to how would achievement and attitudes of students be affected by other intervening variables such as cooperative learning and learning styles within a computer-based learning environment. We asked ourselves would attitudes and performance be enhanced in a cooperative group setting or with independent use of CBI by individuals? Further, we asked would a particular type of learner benefit more by group vs. independent learning in a computer-based lesson?

Background of the Study

Computer-Based Instruction

Research results on computer-based instruction (CBI) provide some guidance for designers.For example, with the abundance of research comparing traditional instruction to computer-based instruction, researchers have found that CBI is as effective or can be more effective in many cases than traditional instruction (Burns & Bozeman, 1981; Niemiec & Walberg, 1985; Kulik & Kulik, 1986; Kulik, Kulik, & Shwalb, 1986; Kulik, Kulik, & Bangert-Drowns, 1985a; Kulik, 1983; Kulik, Bangert, & Williams, 1983; Kulik, Kulik, & Cohen, 1980). Kulik, Bangert, and Williams (1983) also reported that, in some cases, retention may be slightly improved.

Another example is in the research on CBI and attitudes. Although some research results have shown no strong effects on attitude (Robyler, Castine, & King, 1988; Dalton & Hannafin, 1988), the majority of findings indicate that CBI tends to improve attitudes with respect to the computer itself (Kulik & Kulik, 1987; Kulik et al, 1986, 1985a, 1983). In addition, it has been reported that CBI can improve attitudes toward the subject matter at hand (Menis, Snyder

& Ben-Kohav, 1980; Kulik et al., 1987, 1986, 1985, 1983), as well toward instruction in general (Atkinson, 1984; Kulik, et al., 1987, 1986, 1985b, 1983).

Cooperative Learning

Johnson and Johnson (1987) define cooperative learning as the instructional use of small groups so that students work together to maximize their own and each other's learning. A variety of methods of cooperative learning abound in the literature and practice (Johnson & Johnson, 1987; Slavin, 1980a, 1980b; DeVries & Edwards, 1974; Kagan, 1985). Each of these methods vary by the number of students per group, type of learning goals and tasks, and the specific training methodology and procedures employed.

The use of cooperative learning techniques in conjunction with CBI has been seen by some scholars as desirable (Dalton, Hannafin, & Hooper, 1989; Hooper & Hannafin, 1988a,b; Johnson, Johnson, & Stanne, 1985; Johnson, Johnson, & Stanne, 1986; Webb, 1987). It has been found that the use of cooperative learning and CBI have had positive effects on performance (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Johnson, Johnson, & Stanne, 1985; Slavin, 1983b; Dalton, Hannafin, & Hooper, 1989). Although much research suggests that computer-based cooperative learning may promote higher performance than individual instruction, these findings are not conclusive. Carrier and Sales (1987) found no differences in the performance scores of students working in groups and those working individually. Similarly, Sherman (1988) found no significant difference between the performance scores of students learning in a cooperative environment and those learning in an individual environment.

In addition to effects on performance, the use of cooperative learning techniques has had positive effects on student attitudes (Mevarech, Stern, & Levita, 1987; Slavin & Karweit, 1981; Johnson, Johnson, & Stanne, 1986). Again it must be noted that not all studies report positive outcomes in terms of student attitudes (Slavin, 1990; Moskowitz, Malvin, Schaeffer, & Schaps,1983; Madden & Slavin, 1983; Slavin, Leavey, & Madden, 1984; Johnson, Johnson, Scott, & Ramolae, 1985).

Although research on the use of cooperative learning in CBI environments have had mixed results, necessity may be the main reason for its continued use in computer environments. Typical computer classroom/lab settings rarely provide each individual student with a computer (U.S. Congress, Office of Technology Assessment, 1988). Thus, if students are to spend a significant amount of time with CBI, they may have to do so as a member of a group (Trowbridge & Durin, 1984). Because of this restriction, effective instructional methods for helping students work in groups needs to be found.

Based on past research it is noted, however, that other intervening factors such as learning style could affect both performance and attitudes of students learning by cooperative methods. For example, Swing and Peterson (1982), in their investigation of student ability and student behaviors during small-group interaction, found that performance was related to student ability. Similarly, Webb (1982) found that performance was related to ability, but in addition to group composition, gender, and personality. Finally, Hall, Rocklin, Dansereau, Skaggs, O'Donnell, Lambiotte, and Young (1988) administered nine individual difference instruments, measuring a number of characteristics. They also found that individual differences may have an effect on performance in cooperative learning situations. One specific individual difference which may affect performance in cooperative group learning is the learning style of introvert and extrovert.

Learning Style

Learning style differences found in individuals may affect both performance and attitudes in cooperative group learning, as well as in individual learning situations. Learning style refers to an individual's characteristic mode of gaining, processing, and storing information (Davidson, 1990). Although some researchers question its usefulness (Cohen, Hyman, Ashcroft, & Loveless, 1989; Sewall, 1986; Freedman & Stumpf, 1980), others advocate the use of learning style information when investigating the instructional process (Davidson & Savenye, 1990; Davidson, Savenye, & Orr, 1992; Dunn, Beaudry, & Klavas, 1989; Gregorc, 1979; Keefe, 1979; Carrier, Newell, & Lange, 1982; Fizzell, 1984; Clariana & Smith, 1988).

To date, there is little research on the relationship of learning style with student performance on CBI. A recent study by Davidson and Savenye (1990; and with Orr, 1992) suggests there is a relationship between learning style and performance on computer-based instructional tasks. Sharma (1987) also found evidence to support the consideration of learning style in the planning of instructional programs. As Sharma points out, the process of identifying individual learning styles and using this information is not a new idea, however, using it in terms of CBI warrants more study.

Likewise, few research studies have investigated the effects of learning style on attitudes, especially in conjunction with a computer-based lesson. However, one study by Charkins, O'Toole, and Wetzel (1985) showed a relationship between learning style and attitude. Canino and Cicchelli (1988) also found a significant difference in attitudes of subjects involved based on their identified learning style. Finally, research by Davidson and Savenye (1990) also suggests that there is a relationship between learning style and attitude in CBI.

Currently, research does not strongly support the consideration of learning style alone as a variable for improving instruction. However, learning style combined with other instructional variables, such as CBI and/or cooperative learning, may provide insight into which instructional strategies are most effective for different types of learners. It is possible that assignment of students to group or individual instruction, based on their style preference, will lead to improved performance as well as improved attitudes.

Statement of the Problem

Based on descriptions provided by learning style instruments, it was hypothesized that some particular learning styles among individuals would prefer working in groups whereas others with differing styles will prefer working individually. Meisgeier and Murphy (1987) offer a learning style instrument that classifies learners as extraverts (Note: Meisgeier and Murphy's spelling of the term), introverts, or undetermined. Because of these differences in learning style, the focus of this research was to study the effects of the learning style of extroversion-introversion in combination with cooperative learning on both performance and attitude in a computer-based instructional environment.

The purpose of this investigation was to determine the implications of instructional delivery (cooperative learning) and learning style (inrovert-extravert) for the design of CBI environments. Specifically, the study examined the effects of instructional delivery and learning style on performance, as well as attitudes.

Methodology

Subjects

Subjects were 190 elementary students ranging from nine to twelve years of age in either the fourth or fifth grade at an affluent school district in Austin, Texas. Participation in the study was on a voluntary basis, requiring parental consent. Subjects were randomly assigned to one of six experimental conditions stratified by their individual learning style. Approximately equal numbers of fourth and fifth grade subjects would be assigned to the cooperative group and individual conditions.

Treatment Materials

Cooperative Training. The cooperative learning methodology chosen for this study was Learning Together (Johnson & Johnson, 1975). Learning Together is a cooperative learning method emphasizing five major elements: positive interdependence, face-to-face interaction, individual accountability, interpersonal and small group skills, and group processing. Learning Together was chosen based on its ability to be easily adapted to existing curriculum materials. (Note: It was only used with the CGI group.)

CBI Lesson. The instructional materials used in this study included a computer-based tutorial on astronomy, specifically on mapping the night sky. The title of the software was "An Introduction To The Night Sky" (Orange Cherry Software, 1987). Basic principles of astronomy were a part of the existing school curriculum at the fourth and fifth grade level, therefore, the lesson provided a logical extension to the district's required objectives. The software ran on Apple IIe and Apple IIgs machines which were housed in the school computer lab; there were eighteen computers. In addition to the software, the researcher developed a handout of terms and procedures that were included in the program to assist students in pulling out relevant information.

Performance Measures. Performance was measured by a 29-item multiple choice paper and pencil test. The posttest was administered twice--once immediately following instruction and again, one week after instruction with the items appearing in a slightly different. Reliability of the immediate posttest was .75 and delayed posttest .77 (coefficient alpha).

Attitude Measures. Pre- and post-attitude questionnaires were given to assess student attitudes toward receiving instruction through either cooperative group or individual delivery methods. The attitude questionnaire was a Likert-type scale consisting of 8 items. Reliability of the pre-attitude instrument was .77 and .79 for the post-attitude instrument.

Learning Style. The Murphy-Meisgeier Type Indicator (MMTIC) (Meisgeier & Murphy, 1987) served as the measure of individual learning style preference. It is based on the same philosophy and learning theories as the Myers-Briggs Type Indicator but intended for second through eighth grade students. It is a self-report instrument consisting of seventy items.

Cooperative Learning Check Test. The check test, developed by the researcher, served to measure the knowledge of cooperative learning roles and skills. The check test consisted of ten yes/no items and had a reliability of .42.

Cooperative Learning Observation. A supplemental measure of cooperation during the study was taken. An instrument, developed by the researcher, to record observations of cooperative behaviors in groups was used. This was an eight item Likert-type scale to which the observer was instructed to respond as a means to gage a range of cooperation from high to low.

Research Design and Analysis

The design of this study is a factorial design (2 instructional delivery conditions X 3 learning style conditions). The independent variable of instructional delivery had two levels: cooperative group instruction and individual instruction. For the purposes of this study, cooperative group instruction (CGI) was defined as three-member groups working together implementing cooperative learning strategies, such as positive interdependence, face-to-face interaction, individual accountability, interpersonal and small group skills, and group processing, to complete the assigned instruction (Johnson & Johnson, 1987). Individual instruction (II) referred to one learner working through the assigned instruction independently.

The second independent variable was learning style, with three levels as determined by the Murphy-Meisgeier Type Indicator for Children (Meisgeier & Murphy, 1987). The three learning styles were: extravert, undetermined, and introvert. This instrument provides cutoff scores which categorize subjects as one of these three types.

Both posttest performance and attitudinal data were analyzed with analysis of covariance techniques (ANCOVA) using school achievement as the covariance. Support data on the cooperative learning skills behaviors (check test and observation record) were also analyzed to determine if skills were understood and used by subjects.

Experimental Procedures

The classroom teachers and the computer lab teacher were taught cooperative learning skills based on the Learning Together Model (Johnson & Johnson, 1987) by the researcher. Lecture and overheads were used to present the information.

Subjects were randomly assigned by the researcher to one of six experimental conditions, stratified by individual learning style. The six experimental conditions, all receiving instruction via computer were:

1. Cooperative Instruction and Extravert (CE)
2. Individual Instruction and Extravert (IE)
3. Cooperative Instruction and Undetermined (CU)
4. Individual Instruction and Undetermined (IU)
5. Cooperative Instruction and Introvert (CI)
6. Individual Instruction and Introvert (II)

Students assigned to CGI group were taught cooperative learning roles and skills by their classroom teachers and given opportunities to practice them for two weeks, 10 minutes per day, prior to attending instruction in the computer lab. A cooperative learning check test was administered prior to the study. A paper and pencil test, following two weeks of cooperative learning instruction, served as a measure of student knowledge of cooperative roles and skills.

The majority of the study took place over a period of three days and in the school computer lab. Because intact classes were used, both groups and individuals were required to work at the same time in the computer lab. On Day 1, subjects were briefly introduced to the study. Cooperative learning roles and skills were reviewed briefly for the CG treatment groups. Subjects received the pre-attitude questionnaire and introduced to the lesson and actual software. On Day 2, after a brief review of general instructions and cooperative learning skills, subjects spent the forty-five minute period interacting with the CBI software. The computer lab teacher monitored the students' behavior and assist them if they had problems with the computers (not the lesson). The researcher and other observer were present to observe the subjects' behaviors in the CG treatments. On Day 3, again after the review, an additional twenty minutes of instructional time was given. At the end of the CBI time, the immediate performance test was administered followed by the post-attitude questionnaire. One week later, the delayed performance posttest was administered by the classroom teacher.

Summary of Results

Performance

The 2 x 3 x 2 analysis of covariance (ANCOVA) with repeated measures on the last factor revealed no significant differences among the six experimental conditions for performance. There was no significant main effect for instructional delivery, nor was there a significant main effect for learning style. In addition, no significant interaction was found between the two variables. The repeated measures analysis revealed no significant differences between the immediate and delayed performance scores.

Scores on the California Achievement Test (CAT) Science sub-section (covariate) were found to be significant. This indicates that there was a relationship between the covariate (CAT scores) and performance.

Attitude

Analysis of covariance (ANCOVA) revealed no significant differences among the six experimental conditions on attitude. Once again there was no significant main effect for instructional delivery, nor was there a significant main effect for learning style. In addition, no significant interaction was found between the two variables. Scores on the pre-attitude questionnaire (covariate) were found to be significant. This indicates that there was a relationship between the covariate (pre-attitude questionnaire) and attitude.

Support Data

Although no formal hypotheses were formulated for the following analyses, they were areas related to the previously stated hypotheses and served to support or elaborate on the findings associated with them. Mean scores on the cooperative learning check test were above 88% for all six experimental conditions. This information supports the previous research questions and hypotheses in that one can probably assume that subjects had a fairly good understanding of the roles and skills they were supposed to use during the study. Tallies from observations of cooperative learning groups (tallies of roles and skills performed during interaction with the instructional materials) indicated that subjects with an undetermined learning style exhibited the highest use of cooperative roles and skills followed by those subjects with an introvert learning style and finally subjects with an extravert learning style. Differences among the groups were small, however. On an overall rating of cooperation, extravert subjects were ranked highest in terms of cooperation, followed by undetermined subjects, and finally introvert subjects.

In summary, the results of this study failed to support the hypotheses for interaction between instructional delivery and learning style for both performance and attitude. This lack of support may have been due to methodological, rather than conceptual reasons. It is possible that specific details or limitations of this study may have contributed to the lack of significant findings. Based on the inconclusive results, some recommendations for further research and practice are made.

Recommendations for Further Research

Cooperative Learning Instruction

Although it appears that subjects understood the limited number of cooperative learning roles and skills included in this study, not all in the CG treatment group performed the skills automatically. They may not have had sufficient time to practice them in the ten minute periods, nor were they prompted to use these skills during the remaining class periods in order to fully internalize these cooperative learning skills. Derry and Murphy (1986) suggest that new skills, such as these cooperative learning skills, be practiced and prompted for better transfer.

It is recommended that cooperative learning techniques (roles and skills) be taught to subjects participating in a study, such as was the case in this study, rather than assuming subjects already possess this knowledge. However, it is also recommended that this instruction last for a longer period of time before conducting the actual research study. It is recommended that both the overall length of time (two weeks in this current study), as well as the amount of time (ten minutes per day in this study) be lengthened.

Type of Computer-Based Instruction

The current study results are limited to computer-based tutorial environments. It is also suggested that this study be replicated with a different type of CBI. It is possible that the type of instruction may have an effect on the results found. It is suggested that simulation or problem solving type software be used, since these types of software lend themselves more to discussion between group members than does a tutorial.

Learning Style

It is recommended that more subjects be included in research such as this, where subjects are identified and assigned to experimental conditions based on their individual learning style. This is desired since there is a strong possibility of obtaining disproportionate numbers of learning style types.

Using older subjects is also suggested for further research because their learning style may be more fully developed and stable than the subjects in this current study. In addition, it is recommended that subjects of different socioeconomic backgrounds, as well as subjects with a wider range of ability levels be included. Such variations in subjects would increase the generalizability of the findings.

How the subjects are grouped is another possible area for further research. In this study, by nature of the design, cooperative learning groups were comprised of all one learning style. Another area of possible research would involve having subjects of various learning styles grouped together. Findings different from those obtained in this study may be obtained.

Motivation

Although students performed and completed tasks, their full attention, motivation, and/or interest may not have been on this lesson. It is believed that these characteristics may have been lacking in this study, due to the fact that the research occurred so late in the school year. Conducting research earlier in the year may eliminate this possible problem.

Another motivational issue was the incentive provided to make subjects think it worthwhile to participate in cooperative learning groups. It is recommended that the incentive be made more appealing, so that group members would be more likely to consider it worthwhile to participate, and therefore exhibit more evidence of cooperative learning roles and skills.

Recommendations for Practical Application

Classroom Teaching

Cooperative Learning and CBI. There are still not enough computers to make CBI an integral part of classroom instruction (U.S. Congress, Office of Technology Assessment, 1988; Hannafin, Dalton, & Hooper, 1987). The use of cooperative learning in conjunction with CBI may be one method for solving the problem of lack of computer equipment for students.

Information from this investigation may help school personnel in the decision making process regarding computer hardware and the location of it. One of the primary decisions, at the building level, is whether to have computers centrally located, or to house computers in individual classrooms. The results of this study show no difference in performance or attitude between students working in groups or individually. If it is possible to allow students more access to the computer by working in groups within their individual classroom rather than limited time in a computer lab, according to the results of this study, no significant decrease in performance or attitude should be expected. Therefore, when appropriate, group work may be one way to increase student access to computers.

Learning Style. In terms of learning style, this investigation showed that individuals do differ in terms of learner characteristics. Although no statistically significant interactions were found, this research may serve to encourage educators to continue to identify and recognize individual differences in the classroom. Once these differences are acknowledged, educators may then make appropriate instructional decisions responsive to the needs of their particular students.

Instructional Design

Cooperative Learning & CBI. The combination of CBI and cooperative group instruction offers a unique opportunity for learning. Along with this opportunity, comes implications for instructional design.

For instance, there appears to be a need for software appropriate for group use. Much of the instructional software available was not designed for group use. In addition, instructional design principles should be applied to materials appropriate for groups, regardless of the medium.

Learning Style. A second recommendation is the consideration of the target population. One step in most instructional design models is an analysis of the target population. Although learning style, as a specific learner characteristic, did not produce significant results in this study, consideration of learner characteristics is still an important part of the design process. Possibly learning style, in combination with some other variable, or under different conditions, would produce different results.

Summary

It was the intent of this study to provide information about the effectiveness of computer-based cooperative learning with different types of learners as characterized by their individual learning style. This researcher had hoped to find an interaction between instructional delivery, specifically cooperative learning, and learning style. Although results were not statistically significant, continued research and practice is encouraged in these areas so that teaching and learning may continue to improve. The findings of this study and subsequent recommendations for practice may be useful for instructional designers and classroom teachers to increase performance, as well as improve attitudes of individual learners.

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Title:

Instructional Strategies for Metacognitive Development: An Inservice Design

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Instructional Strategies for Metacognitive Development: An Inservice Design

Introduction

The impact of the "cognitive revolution" on instructional design (ID) has been substantial. From the development of ID models to their application, instructional technology theorists continue to bring cognitive psychology and human information processing theory to bear. The concepts and empirical findings of cognitive science are "helping to guide ID toward new understandings of how people learn and how to design instruction for optimal results" (Ely, 1992, p.44). There is widespread agreement that each learner needs to learn **how** to learn if they are to compete in the technological world that awaits. So, in addition to the dozens of other instructional priorities of today's classroom teacher, this author suggests that we must also instruct learners in metacognitive strategies: those strategies which allow the learner to maintain awareness and control of their learning, to choose particular strategies for use, and to self-monitor the use of a variety of strategies.

West, Farmer and Wolff (1991) make a strong case for embedding the instruction of these strategies within the content. Research supports the effectiveness of metacognitive training within varied content domains (Pressley, Snyder & Cariglia-Bull, 1987; Hansen & Pearson, 1983; Brown, Campione & Day, 1981). While these control strategies are internal, learning how, when, where and why to use them will be aided by incorporating their instruction with content instruction (West, *et al*, 1991, p.19).

Classroom teachers are typically not trained in the practical applications of cognitive science or human information processing theory. Most practicing teachers have had little exposure to instructional design principles or the cognitive theories which support effective instruction. Nonetheless, all teachers design instruction (Briggs, 1977, p.179) at various levels with various expectations for the learner. The inservice described here is designed to teach instructional strategies that promote metacognitive development to these "front-line" instructional designers. Fundamental to this inservice design is the notion that instruction in metacognitive strategies must be incorporated into their content instruction.

Description of the Inservice

Teachers have a strong sense of **what** they want their students to learn, but they have a weaker sense of **how** they can most effectively help students learn, retain, and transfer their knowledge. This inservice design is predicated on helping teachers learn about eight specific metacognitive strategies and how to embed strategy instruction within the instruction of content objectives. Strategies addressed are: chunking, framing, and concept mapping (organizing strategies), use of metaphor and use of advance organizers (bridging strategies), rehearsing, use of imagery, and use of mnemonics (multipurpose strategies). This inservice is not intended to be a comprehensive treatment of these strategies, nor an all-encompassing exposure to metacognition, but an introduction to effective metacognitive strategy instruction.

Application is directed at the secondary level (any content area) but may easily be adapted/extended for instructors at any level, K-adult. Participants are expected to be novice to expert certified secondary instructors and/or administrative personnel. The inservice design and companion reference manual/workbook incorporate the control strategies previously listed. Gagne's nine events of instruction serve as the defining methodological structure for the inservice because most classroom teachers can relate to and recognize these events as an instructional model they have implemented themselves. The reference manual/workbook is intended to serve as a personalized teacher reference at the conclusion of the inservice; it is not intended to be a stand-alone, self-instruction module. A delivery format of two distinct one day sessions is suggested, but might be re configured to about twelve one hour sessions.

Design of the Inservice

Participants begin their journey into metacognitive strategies by addressing four questions: What are metacognitive strategies? Why should I teach metacognitive strategies?

When do I teach metacognitive strategies? and How do I teach metacognitive strategies? Discussion of each of these questions includes a brief look at related research and the supporting cognitive theory. Requiring the learner to be an active participant in their learning environment, motivation, and meaningful learning are examples of the concepts reviewed. This author presents an eight step iterative instructional model specifically created to provide teachers with a structure for embedding metacognitive strategy instruction within content instruction.

Once this conceptual foundation is in place, the inservice focus shifts to the eight specific strategies mentioned previously. Content instruction for each strategy includes: a definition of the strategy, a discussion of the value of the strategy, examples of practical, everyday applications of the strategy, an activity related to the classroom application of the strategy, and modeling of the application of the strategy within the eight-step instructional model. When appropriate, other theoretical constructs are introduced (e.g. types of knowledge, storage and retrieval) and strategies are considered in combination(s) for optimal effectiveness.

The conclusion of the inservice is a discussion of factors which seem to influence the degree of effectiveness of any particular metacognitive strategy. According to Snowman (1986), these factors are (1) the amount and type of previous training in the use of the strategy, (2) the extent to which the learner understands the teacher objectives, and (3) the ability of the learner to recognize appropriate conditions for use. Helping students learn to control their own cognitive processes can have differential effects on their future study behaviors and academic success. This inservice strongly emphasizes that teachers must help students distinguish between working harder and working longer; between working harder and working smarter (Weinstein, Hagan & Meyer, 1991).

Results of Implementation

This author is currently delivering this inservice to a group of approximately fifty secondary instructors from a single high school in northern Colorado. Participants have the option of attending for university or recertification credit or simply for the professional growth opportunity. Three participants are building administrators who have a sincere interest in increasing the quality of the instruction in their school.

While no hard data has yet been collected, the "reviews" are very positive. Attendance at each successive session has increased. Participating teachers find this inservice professionally significant and practical; they are encouraging their peers to attend. Teachers are "won over" when they find that instruction in metacognitive strategies needs to occur embedded within their content instruction, not in addition to their content instruction. They are enthusiastic about the concept of metacognition instruction and the potential for creating an instructional environment where accountability for education is shared; the learner is responsible for controlling their own learning and the teacher is responsible for guiding, supporting, and facilitating that process. Most participants have tried to introduce at least one of the strategies using the eight step instructional model. Within the large group, they share their successes and seek suggestions for revising their instruction. The final test is, of course, whether or not the majority embrace instruction in metacognitive strategies for the long term and adapt their daily instruction to integrate a variety of the strategies presented in this inservice on a regular basis.

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Title:

Effects of Two Practice Strategies on Two Types of Recall

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Effects of Two Practice Strategies on Two Types of Recall

A Research Report Presented at the 1993 Conference of the
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Simi Valley Unified School District

Introduction

Research into the effectiveness of practice strategies for learners has provided much evidence that adjunct questioning, a strategy where questions are inserted following short sections of information (Sutliff, 1986), is an effective educational tool. Adjunct practice questions have been found to facilitate learner recall and promote a higher degree of learner involvement, even when no feedback or opportunity for review are provided (Duchastel and Nungester, 1984; Watts and Anderson, 1971). Adjunct practice questions have been found to provide superior retention in both adults (Hamilton, 1985) and children (Denner & Rickards, 1987), when compared to reading-only conditions with no questions.

Most studies involving adjunct practice questions and learner recall have examined the effects of experimenter- or text-provided questions (Andre & Thieman, 1988; Duchastel and Nungester, 1984; Hamilton, 1986). However, recent interest in the cognitive processing of learners has produced a growing body of literature about learners generating their own practice questions (Cohen, 1983; Gillespie, 1990). Studies of the effects of learner-generated questions have found facilitating effects (Denner and Rickards, 1987; Gillespie, 1990; Steiner, 1988). In theory, having students generate their own practice questions should require that they focus greater attention on the material, thus increasing recall (Gillespie, 1990). It is hypothesized, therefore, that learner-generated adjunct practice questions would be more effective at facilitating the recall of textual information than experimenter- or text-provided adjunct practice questions.

Steiner (1988), differentiated between the recall of lower-order information and higher-order information. Recall of lower-order information involves remembering simple or factual information (Hamaker, 1986). Questions that begin with "who," "what," "where," and "when" are generally seeking lower-order information. Recalling higher-order information requires greater processing of concepts, procedures, or a synthesis of facts, typified by "how" and "why" questions. The purpose of this study was to investigate whether learner-generated or experimenter-provided adjunct practice questions are superior at facilitating recall of lower- and higher-order textual information.

Method

Subjects and Design

The subjects for this experiment were 74 sixth grade students from three classes in a middle class, suburban elementary school in the southwestern United States. They embodied an ethnically mixed group of caucasian, hispanic, black, and asian students. Subjects in each class were randomly assigned to lower-order and higher-order information treatment groups, each containing an *n* of 37.

The design of the study was a 2 (authorship of practice question) X 2 (level of information) factorial which utilized a modified posttest-only design with no control group. The dependent variable was retention of information as measured by performance on an achievement posttest.

Materials

The instructional materials developed for this study consisted of a 4-page booklet containing 12 paragraphs of text, adapted from a chapter on Hinduism in the students' world history textbook. The text material was rearranged so that each paragraph contained both lower-order and higher-order information, however, the basic content was left unaltered. Six of the paragraphs were each followed by an experimenter-provided practice question and a space to answer the question. The remaining six paragraphs were each followed by lines where subjects could generate their own questions and answers. Although the textual material was identical for both treatments, the booklets given to the lower-order group contained only lower- order provided questions The higher-order instructional materials contained higher-order questions. An example of the two types of questions follows:

Lower-order:	What are the four classes in Hinuism?
Higher-order:	If you were born a Hindu, how would your class decide your way of life?

Criterion Measure

The criterion measure was a 24-item posttest, administered one day following the instructional activity. Subjects did not have an opportunity to review the instructional material before taking the test. Test items included one lower-order and one higher-order item for each of the 12 paragraphs in the instructional booklet. En route data of the time required for each subject to complete the examination was also measured. Five students who were absent the previous day and did not receive the instructional materials took the posttest and were unable to answer any of the 24 test items correctly. Internal consistency of the posttest was calculated by using the split-half reliability and Spearman-Brown prophecy formulas, which yielded a correlation coefficient of .83.

Procedures

Approximately one month prior to the study, the subjects received instruction in the generating of lower- and higher-order questions by their classroom teacher. The teacher differentiated between "factual" (lower-order) and "conceptual" (higher-order) questioning techniques and modeled how to generate the different kinds of questions. The subjects were given opportunities to practice questioning skills in class and on homework assignments.

Before administering the instructional materials, the subjects were given a brief review in the difference between "factual" and "conceptual" questions. Subjects in the lower-order question treatment were directed to compose lower-order questions while subjects in the higher-order treatment were directed to compose higher-order questions. The subjects were directed to write answers for all 12 questions.

Results

Posttest means for experimenter-provided and learner- generated practice questions are shown in Table 1. Data for posttest achievement were analyzed using a 2 X 2 factorial analysis of variance. One- and two-way analysis of variance showed a significant effect for authorship of adjunct practice questions at both lower $F(1,72) = 8.87$, $p < .01$, $MSe = 2.20$ and higher $F(1,72) = 10.59$, $p < .01$, $MSe = 2.47$ information levels. The mean scores of the experimenter-provided group were found to be significantly higher than those for the learner-generated group. No significant effects for level of practice question and gender were reported. No significant interaction effects were reported. These results fail to support the hypothesis that generating adjunct practice questions would be superior at facilitating recall when compared to experimenter-provided practice questions.

Subjects in the lower-order group took an average of 5.48 minutes to answer the provided questions and 9.49 minutes to generate questions. Those in the higher-order group took an average of 7.58 minutes to answer the questions and took 12.03 minutes to generate questions.

TABLE 1: Recall by Level and Authorship of Adjunct Practice Questions

Level of Information		Authorship		
		Provided	Generated	Total
Lower-Order	M	3.92	2.89	6.81
	SD	1.57	1.39	2.84
Higher-Order	M	4.03	2.84	6.87
	S	1.38	1.57	2.65
Total	M	7.95	5.73	13.68

Discussion

Both provided and generated adjunct practice questions have been shown to be an effective aid in facilitating recall of text information when compared with a reading-only conditions. Because of the increased cognitive activity required to generate questions, it was hypothesized that sixth grade learners who generated their own practice questions would enjoy superior recall than when they answered provided practice questions. The findings of this study, however, support the superiority of provided questions over generated questions for sixth graders. This finding is consistent with Denner and Rickards (1987), who found that fifth graders recalled subordinate and superordinate details better with provided than with generated questions. This finding, however, was reversed with eighth graders. This result could be due to the fact that sixth graders are more like fifth graders, who may not yet possess the cognitive skills necessary to for the task of generating and encoding interrogatory information.

These results may be due to a high correlation which existed between the provided questions and the items on the posttest. Students who generate practice questions dissimilar to those on the test will be working under a handicap, rather than an advantage. This handicap can be lessened greatly by providing learners with opportunities to receive feedback regarding the quality of their questions, and the chance to revise questions prior to utilizing them for recall practice. The desirability of maintaining a learner-generated adjunct questioning strategy, including extra time for feedback and revision, is an issue that must be decided upon by the individual instructor.

For sixth grade learners, providing questions appears to afford more effective and efficient recall than having the learners generate them. Since adjunct practice questions have been successful as a strategy for learner recall of text information, their continued usage as an instructional strategy is recommended.

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Title:

Learner Control of Feedback in a Computer Lesson

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Although a great deal of research has been conducted on learner control and on feedback, few studies have been conducted to determine if leaner control of feedback will have a beneficial effect on student performance and attitude. According to Clariana, Ross, and Morrison (1991) feedback is an important variable that is often ignored in computer assisted instruction (CAI). Yet, it is possible to design instruction that allows learners to control the amount of feedback after a practice item. Using a computer to administer feedback can be an efficient process. A computer can act as a sophisticated tutor, capable of adjusting feedback to obtain effective and efficient instruction (Anderson, Boyle & Reiser, 1985).

In a previous study, we used program and learner control with two levels of feedback (verification and elaboration). These are the two components of feedback described by Kulhavy & Stock (1989). The results of that study showed that elaboration was significantly more influential than verification in producing greater performance. In this study, we wanted to see if the degree of elaboration feedback needed for high performance could be determined. We used program and learner control at three levels of feedback, which were verification, correct answer and elaboration.

Method

Subjects

Subjects were 126 undergraduate Education majors at a large southwestern university. They were told that the information would be useful to them as future teachers and that they would receive credit for participation in the study.

Procedures

This study was administered by microcomputer and had six conditions with 21 subjects in each group. All subjects read text, answered embedded practice questions and received feedback. They then completed a short attitude survey and a posttest consisting of the practice questions presented in random order.

Before subjects arrived to participate in the study, we prepared the computer laboratory by installing one of the six lessons into each computer. Upon arrival at the computer room, subjects were randomly assigned to each of the six conditions. Subjects were run in groups of about 25 with all conditions present at each session.

We gave a short introduction on general procedures and told subjects that instructions were included in the program. They were not told that the programs were different. Subjects were told that the lesson was on reliability and validity and stressed the importance of the material for them as future teachers. Subjects then proceeded with their individual lessons. Upon completion of the lesson, each subject completed the attitude questionnaire and the posttest on the computer. Subjects were given as much time as they needed to complete the lessons and the criterion measures. Most subjects completed the study within a 50-minute class period.

The differences in treatments occurred in the type of control (program or learner) and level of feedback (verification, correct answer, or elaboration). Under the condition of program control/verification, a computer program delivered feedback telling subjects that their answer was correct or incorrect. Under program control/correct answer, the feedback delivered by the computer was whether or not the response was correct and the correct answer appeared on the screen. Under program control/elaboration, the computer showed subjects whether their response was correct, the correct answer, and a short explanation.

The three learner control conditions contained the same levels of feedback as program control conditions, but only appeared when learners chose to see the feedback for their condition. After learners responded to a practice question, they were asked one of three sets of questions as follows: 1) For the verification group - Would you like to check you answer? 2) For the correct answer group - Would you like to check you answer? Followed by - Would you like to see the correct answer? Or 3) For the elaboration group - Would you like to check your answer? Followed by - would you like to see an explanation?

Materials

Materials used in this study were six computer programs, a posttest, and an attitude questionnaire. The computer based lessons were developed from the text Topics in Measurement: Reliability and Validity by Dick & Hagerty (1971). Information and examples were presented in sections of five screens of text, followed by eight, five-alternative, multiple-choice questions. This cycle continued for a total of 25 screens of text and 40 questions.

Differences in the lessons were based on type of control (program or learner) and level of feedback (verification, correct answer, or elaboration). Program control groups received one of the levels of feedback automatically. Learner control groups received verification, or correct answer, or elaboration when they requested feedback. Because verification was given to program control groups at all levels, learners with control in the correct answer and elaboration groups had to choose verification before they could choose to see the level of feedback assigned to that condition.

In addition to the six computer based lessons, a posttest and an attitude questionnaire were developed. The posttest consisted of the same 40 questions previously given as practice but presented in random order. The reliability of the posttest was calculated at .69 using the Kuder-Richardson 20 formula. The attitude questionnaire consisted of ten items measuring student satisfaction, enjoyment, perception of control, and feeling toward feedback. The questionnaire used a five point Likert-type scale. Both measures were administered on the computer. In addition, the computer automatically recorded the number of seconds each subject spent studying feedback messages.

Design

The design was a 2 x 3 factorial with type of control (learner or program) and level of feedback (verification, correct answer, or elaboration) as the independent variables. The dependent variables were performance, attitude, and feedback study time.

Results

Retention as measured by performance on the posttest revealed the influence of type of feedback. The mean scores for program control subjects on the posttest were 21.4, 29.7 and 30.8 for verification, correct answer and elaboration feedback respectively. The standard deviations associated with each mean were 4.8, 3.8 and 4.8 respectively. The mean scores indicated that when subjects were given the correct answer or the correct answer with elaboration, subjects performed better on a posttest than if they were only given verification. A similar pattern occurred for learner control subjects.

The mean scores for learner control subjects on the posttest were 20.3, 23.7 and 25.0 for verification, correct answer and elaboration feedback respectively. The standard deviations associated with each mean were 4.2, 7.5 and 6.4 respectively. Here again the same pattern of increased performance with increased amount of feedback emerges, but not as strongly as for program control subjects. Subjects who received verification feedback only did not perform as well as subjects who received either correct answer or elaboration feedback. Subjects who received elaboration feedback performed best whether they were program or learner control subjects. Program control subjects performed better on the posttest than learner control subjects at comparable feedback levels.

An ANOVA analysis revealed significant main effects for scores on the posttests with type of control at $F(5,120)=19.67$, $p<.05$ $MSe=29.42$ and level of feedback at $F(5,120)=20.17$, $p<.05$ $MSe=29.42$. However the interaction did not reach the standard .05 level of significance. The interaction was significant at the .06 level.

The results of feedback study time showed that program control subjects spent more time studying feedback than learner control subjects. Program control subjects averaged 44.2, 101.7 and 232.0 seconds respectively for verification, correct answer and elaboration conditions. However, learner control subjects spent 26.5, 37.4 and 82.1 seconds for equivalent feedback conditions. An ANOVA analysis of feedback study time revealed a significant interaction $F(2,120)=22.46$, $p<.001$ $MSe=2101.90$.

To analyze the attitude survey, a MANONA analysis was first run to see if there were significant differences between the groups on all questions combined. Results revealed a significant MANOVA effect for level of feedback $F(20,100)=2.12$, $p<.05$. Follow-up univariate analysis showed two questions to be highly significant. The one question was "I would have liked more control over the lesson" $F(2,120)=5.31$, $p<.01$. The other question was "I would have liked more feedback about my answers" $F(2,120)=13.90$, $p<.01$.

Discussion

This study and the original study both demonstrated that verification feedback alone was insufficient for subjects to reach high levels of performance on a posttest. This study showed only a minimum improvement (one question on the forty-question posttest) when elaboration was added to the correct answer feedback. The additional time and expense needed to design the instruction with elaboration feedback is probably not warranted. Students would perform at almost the same levels when only given the correct answers.

The pattern of improved performance from verification to correct answer to elaboration was seen in both program and learner control conditions. Program control subjects always outperformed learner control subjects. This would lead one to recommend program over learner control. It should be mentioned, however, that there were greater differences in the standard deviations for learner control correct answer and elaboration conditions (7.5 and 6.4) than for the other four conditions. Those conditions ranged from 3.8 to 4.8. The larger deviations were a result of several learner control subjects choosing very little feedback and doing poorly on the posttest but not poorly enough to be considered outliers that could be dropped from the analysis.

The results for the feedback study time were as expected. Learner control subjects spent less time studying feedback than program control subjects. When subjects were given the opportunity to skip feedback, they tend to do so. This resulted in lower scores on a posttest. Sometimes lower scores are offset by improved attitude toward the instruction. That was not the case with the current study.

No differences were found between types of control on the attitude study. The only differences were for level of feedback. Subjects who were only given verification were universally displeased with the lack of control and lack of feedback.

This study would suggest that program control with correct answer feedback is the most effective and efficient way to present instruction on a computer. However, additional research with different subject matter and different age subjects would be warranted. More sophisticated programs could also be developed that would only allow learners to omit feedback when they have given correct answers. That situation may keep scores high and improve attitude.

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Title:

An Assessment of the Effectiveness of a Hypertext Instructional Delivery System When Compared to a Traditional CAI Tutorial

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An Assessment of the Effectiveness of a Hypertext Instructional Delivery System when Compared to a Traditional CAI Tutorial

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More than 40 years ago, Vannevar Bush, science advisor to President Roosevelt, proposed a hypothetical machine, the MEMIX, that would allow individuals to browse through information, photographs, maps, and sketches by using links connecting any two source documents. The visionary image provided by Bush coupled with significant advances in computers, software, and high capacity fast access digital storage devices have given rise to databases that today contain documents, graphics, sound, speech, and animated sequences. A database containing information in these varied formats which supports the non-sequential access of information by the user has been coined hypertext.

Hypertext can be visualized as a 'semantic' network of nodes and links. In this model, nodes represent information units (e.g. documents, graphics, sound, etc.) while links serve as the cross-reference threads connecting related nodes. The links connecting nodes are usually denoted by highlighted words, phrases or graphics and are activated by using a mouse or arrow keys to select it. Depending on its purpose and location, a link can: transfer the reader to a new but related topic, show a reference or serve to move from a reference to the article, provide ancillary information, display a related illustration, schematic, photograph or video sequence, display an index or access and run a related application program.

The development of hypertext systems has grown rapidly during the last decade. Today, applications which utilize hypertext include: online help and documentation resources, software engineering tools, encyclopedias, reference manuals and books, and computer assisted learning in numerous educational disciplines.

Hypertext has three characteristics that are not present in traditional instruction which relies heavily on a highly directed flow of information. First, hypertext systems allow huge collections of information in a variety of mediums to be stored in an extremely compact form and accessed easily and readily. The stored information can be linked both explicitly and implicitly. Explicit links can be used by authors to suggest paths through information which learners may or may not choose to follow. Implicit links can be included which support glossaries, dictionaries, and navigational aids to be used as needed by the learner (Marchionini, 1988).

Second, hypertext is an enabling rather than directive environment. Hypertext systems encourage the user to probe information sources. By selecting the order, number, and composition of the nodes accessed, one can acquire and process information in ways that capitalize on their individual cognitive and experiential framework (Schneiderman, 1990). Learning theorists contend user initiated movement also increases the number of retrieval pathways available to access encoded information from the user's own long term memory (Jonassen ,1988). Not only does hypertext offer a new way to learn course content but also offers a new way of learning how to learn.

Third, hypertext offers the potential to alter the roles of teachers and learners and the interactions between them. The flexibility of hypertext enables students to create unique paths and interpretations of the paths which later can be shared with teachers or other students (Marchionini, 1988).

Conversely, others argue that hypertext is less than optimal. Learner control, aptitude-treatment interaction (ATI), disorientation and cognitive overhead are problems often associated with hypertext.

For some learners, the degree of control afforded by hypertext may negatively affect learning. Tennyson and Rothen's (1979) research on learner, adaptive, and program control strategies employed in computer based instruction concluded that learner control consistently yielded lower post-test scores than other control strategies partially because students terminate[illegible]nstruction too early. Because of the richness of the medium, learners may not know what sequence or content area of hypertext are best for themselves to reach desired learning objectives. Some suggest that the less familiar subjects are with the content of the unit to be mastered, the greater the need for support in the form of clearly stated learner objectives. Such objectives provided to the learner could serve as a 'checklist' indicating to the learner what must be learned while using the hypertext system. Objectives used in this manner provide additional guidance and direction as learners utilize hypertext for instruction.

Other issues related to instructional control appear to be directly related to the learner himself. Hannafin (1984) concluded from reviewing relevant research that learner control is favored over program control when: (1) learners are older and more mature; (2) learners are more capable; (3) and higher order skills rather than factual information are being taught. Stated another way, hypertext may not be the best mode of instruction for all learners or content areas.

Aptitude-treatment interaction phenomenon may be also be aggravated by the lack of structure in such a learning environment. Research by Clark (1982) indicates low-ability students have higher achievement from more structured instructional methods whereas they prefer less structured methods. On the other hand, high-ability students, he claims, will generally prefer more instructional support but may actually perform better when given leaner, less elaborated material where they must take more responsibility for generating encoding strategies. Lower ability students, who need the additional support, may decline to seek it. He hypothesized that both groups prefer what they perceive will demand the lowest 'mental workload' for themselves.

Additionally, Steinberg (1977) addressed the issue of ATI. She suggested that while high achievers seem capable of using most forms of learner control effectively, low achievers seem much less able to make decisions about instructional properties (what, how, or how much information) than from those decisions involving variations in presentational aspects (how information is formatted or delivered). Her research findings suggest when instructional decisions need to be made, better learning is likely to occur with external coaching or advisement regarding which resources to select. Aptitude-treatment interaction research suggests hypertext may not be the most effective environment for low achieving learners. Perhaps a strategy which prescribes closer assessment of learning by the instructor may be necessary.

Disorientation is the result of more degrees of freedom, more dimensions available in which one can move. Technical solutions to disorientation are: (1) graphical, map-like models which depict the current hyperspace and identify the user's position within the space; (2) and providing a means for the learner to backtrack.

Graphical models termed context webs and local maps are used in Brown University's Intermedia system. In this hypertext system, nodes consisting of documents, graphics, sound, and animation related to the same context are grouped to form a web. Using this model, every node belongs to one or more web. When the user activates a node belonging to a web, they can visually see the other links and nodes which also belong to the active web. In addition, a local map can be activated which only shows the present active document and its closely related neighbor nodes (Conklin, 1987).

HyperCard and other developmental shells offer a back-tracking function. By clicking on an icon representing a prior screen, the user is able to move directly to that screen thus enabling a rapid review of previously encountered information.

The additional mental effort and concentration required to make choices about which paths to follow and which to leave alone can result in 'information myopia' or cognitive overhead (Conklin, 1987). Cognitive overhead may be reduced if the user is able to more effectively organize and integrate the new chunks of information extracted from the hypertext medium with existing prior knowledge.

To date, little research has been conducted to support or resolve the above mentioned issues related to hypertext systems. Research performed by Egan, et. al. (1987) and Landow (1989) support the contention that hypertext systems do in fact support a richer learning environment. Other studies conducted by Covey (1990), Lanza and Roselli (1991), Mays, Kibby, and Watson (1988), and Tripp and Roby (1990) indicate hypertext delivery systems were less effective than other instructional systems.

This study examines differences in traditional student performance measures following a CBI tutorial or a hypertext approach for mastering concepts related to intellectual property (copyright and patent) law.

Method

Subjects

Seventy six voluntary subjects in the study were enrolled in an undergraduate introductory business law course required by all majors in the College of Business at a midwestern state university. The subjects were divided into two treatment groups: one group received instruction using a CBI tutorial and the other group received instruction delivered in a hypertext format which utilized graphical maps. When queried prior to treatment, all participants indicated they had a general awareness of the topic of the instruction, copyright and patent law, but knew nothing about the legal issues and implications related to the subject area.

Each subject received an ability ranking by their current business law professor prior to the study. The levels were based on eight weeks of observations which included assignments and tests.

Each system also contained a HyperCard script which created an audit trail which recorded the movement of each subject as he moved through the the HyperCard stack.

Programs

Two computer based applications, a tutorial and hypertext system, were developed using HyperCard and its authoring language HyperTalk. Both contained identical subject matter but varied in the amount of personal control and structure offered to the user.

In the tutorial, students were presented with a main menu listing the topics in the proper order of study. Once a topic was selected, the subject was required to move through all the related instruction prior to selecting another topic. No restrictions were placed on the number of times a topic could be selected for study.

The hypertext system presented the same topics for study but made no attempt to identify or impose an order in which the topics should be studied. In this system, once a subject area was selected, the student was presented with a graphical map which served to identify the informational nodes associated with the topic as well as depicting how they were related. To move to a node shown on the graphical map, the subject was required to click on the node. A subject using the hypertext system had three control options at any given time: continue to move linearly through the information associated with the selected node; return to the graphical map of the topic and select another related informational node; or return to the list of topics presented and select another topic.

An example of the menus available for both the tutorial and hypertext systems (Figures 1 and 2) are appended at the end of the paper.

Embedded within both systems were numerous opportunities for students to check their comprehension of the subject matter through the use of 'what if' applications. In each situation where responses were solicited and obtained, diagnostic feedback was provided.

Facilities

Both groups used equipment in an academic computing center at a state university in southern Minnesota. The equipment consisted of Macintosh SE computer systems with internal hard drives.

Instruments

The instrument used to measure the students' performance was composed of 30 multiple choice questions reflecting both recall and and application of the concepts presented in the software. One point was allocated to each question. This instrument was used as both the pre-test and post-test assessment instrument.

The reliability of this instrument as determined by a KR-20 analysis was .688.

Procedure

The procedure used in this study was as follows:

1) Two days prior to the study, subjects unfamiliar with the Macintosh platform used to deliver both forms of instruction received an intensive two hour training session.
2) Treatments were assigned randomly. Detailed instructions on effective use of the assigned treatment as well as a practice period using software similar to the assigned treatment was implemented for each participant.
3) After the practice period, subjects were administered a pre-test and given objectives reflecting the subject material to be mastered.
4) Participants were administered a treatment consisting of either the tutorial or hypertext system and post-test under supervision of the researcher. No time limit was placed on viewing the software.

Results

Table 1 reports the t-test analysis which was applied to the results of the post-test to assess the difference in performance between the tutorial and hypertext treatments. No significant difference was found at the .05 level.

Table 1. Tutorial vs. Hypertext Group Post-Test Results

	N	Mean	S.D.
Tutorial group	37	20.158	3.6865
Hypertext group	39	18.313	3.6160

t(74) df=.45 p=.643

A t-test for paired samples (pre-test, post-test) analysis when applied to the two treatment groups is represented in Table 2. Significance was found at the .05 level for both treatments.

Table 2. Tutorial vs. Hypertext Group Paired Pre-Test, Post-Test Results

	N	Mean	S.D.	p
Tutorial group				
Pre-test	37	12.4054	2.544	.029
Post-test	37	18.5405	4.018	
Hypertext group				
Pre-test	39	13.0513	3.268	.005
Post-test	39	18.8205	3.546	

Table 3 depicts the t-test for paired samples (pre-test, post-test) analysis when applied to the three ability groupings. Significance was found at the .05 level for both low ability and medium ability groups.

Table 3. Ability Groups Paired Pre-Test, Post-Test Results

	N	Mean	S.D.	p
Low ability				
Pre-test	21	11.8571	3.321	.036
Post-test	21	17.0000	3.987	
Medium ability				
Pre-test	36	12.7500	2.951	.030
Post-test	36	18.1389	3.217	
High ability				
Pre-test	19	13.6842	2.212	.902
Post-test	19	21.5789	2.893	

A one-way analysis of variance (Table 4) showed no significance at the .05 level between ability and the pre-test scores but significance at the .05 level between ability and the post-test scores. Further follow up with the Scheffe procedure indicated ability groups one and two (low and medium ability) and groups two and three (medium and high ability) were significantly different at the .05 level.

Table 4. One Way Analysis of Variance Pre -Test, Post-test by Ability

Dependent variable	Source of Variation	df	SS	MS	F	p
Pretest	Between Groups	2	33.3102	16.6551	1.982	.1451
	Within Groups	73	616.4267	8.4031		
Post-test	Between Groups	2	229.4839	114.7420	10.081	.0001
	Within Groups	73	830.9371	11.3827		

The data associated with screens viewed per treatment is summarized in Table 5. No significant difference between means was found at the .05 level.

Table 5. Tutorial, Hypertest Screens Viewed

	N	Mean	S.D
Tutorial	37	123.824	26.903
Hypertext	39	118.324	15.813

A one way analysis of variance (Table 6) showed significance at the .05 level between the post-test tutorial scores and ability groupings while no significance was found between post-test hypertext scores and ability groups.

Table 6. One Way Analysis of Variance Treatment Post-test Scores by Ability

Dependent variable	Source of Variation	df	SS	MS	F	p
Tutorial treatment	Between groups	2	210.6237	105.3118	9.5181	.0005
	Within groups	34	376.1871	11.0643		
Hypertext treatment	Between groups	2	31.2526	15.6263	1.0781	.3513
	Within groups	36	507.3000	14.4943		

Discussion

The purpose of this study was to assess, in an undergraduate university setting, the effectiveness of a hypertext instructional delivery system when compared to a traditional CAI tutorial. Several findings which relate directly to problematic issues of learner control and ability were noted.

Learner control over the number of informational screens viewed was not found to be a factor in overall subject performance. Quantitative examination of the audit trail compiled by each subject's treatment indicated there was no significant difference in the number of subject matter screens viewed by the tutorial versus hypertext treatment groups. Subjects in both treatment groups appear to have taken the treatments earnestly. Each treatment group viewed nearly one fourth of subject screens twice. The novelty of the instructional mode should not be ruled out in further studies as a factor which may play a significant role in this aspect of evaluating learner control.

Although learner control in this study did not hinder a subject's ability to navigate through the screens, it did not facilitate a greater understanding of the material as assessed by the post-test instrument. Neither treatment was found to achieve a greater measure of learning of intellectual property law.

There are indications from this study that ability plays a major role in assessing the effectiveness of a tutorial versus hypertext instructional systems. Examination of post-test performance when viewed in relation to treatments and ability groupings revealed variations. No significant differences in post-test scores were found between the three ability groupings in the hypertext treatment. Even though practice using a similar hypertext system was done prior to treatment, the subjects' lack of experience and unfamiliarity with non-linear learning may have been a factor in these results. Another factor may relate to the instrument used for evaluation. Perhaps a different method of assessment which emphasizes the broad scope of potential associations made in hypterext environments may be more suitable. Significant results were obtained between the low and high ability groups as well as the average and high ability groups in the tutorial treatment. These results indicated the tutorial was most effective for high ability subjects.

This study was an attempt to assess the effectiveness of tutorial versus hypertext delivery systems and to identify learner characteristic which may be used to prescribe the most beneficial mode of instruction. Overall, findings indicate learner control was not a factor in the hypertext mode of instruction. Additionally, ability appears to play a key role in the effectiveness of the tutorial as determined by the post-test instrument while it had little if any effect on subject performance as determined by the post-test instrument in the hypertext mode.

This study set forth additional questions to be answered through research. What type of instrument most effectively assesses learning in hypertext environments? Can different learning styles or learner characteristics be used to predict success in a tutorial or hypertext system? Does novelty play a role in tutorial, hypertext, or both forms of instruction systems? Can quantitative analysis of audit trails provide insight to designers of hypertext systems? Answers to these questions and others must be sought to validate the use of hypertext as an instructional system.

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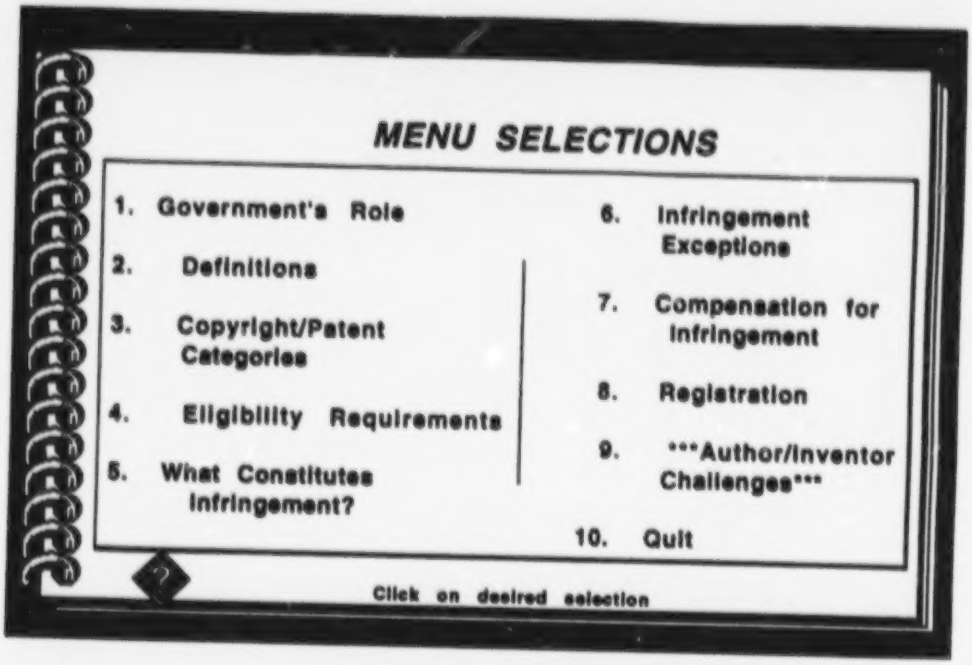
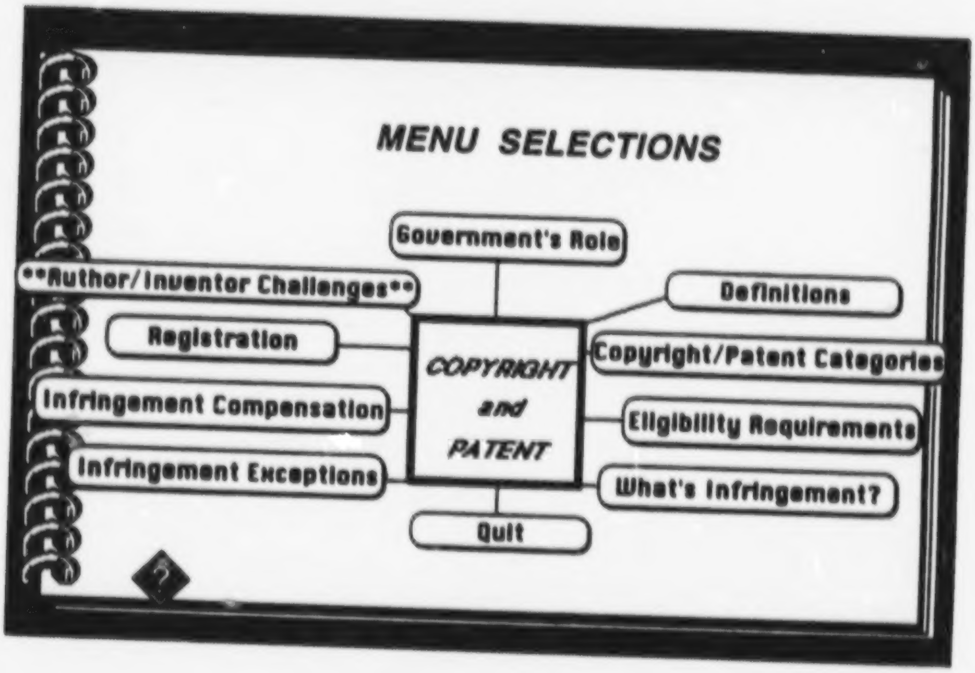


MENU SELECTIONS

1. Government's Role
2. Definitions
3. Copyright/Patent Categories
4. Eligibility Requirements
5. What Constitutes Infringement?
6. Infringement Exceptions
7. Compensation for Infringement
8. Registration
9. ***Author/Inventor Challenges***
10. Quit

Click on desired selection

Figure 1. Tutorial Main Menu



MENU SELECTIONS

Government's Role
Author/Inventor Challenges
Definitions
Registration
COPYRIGHT and PATENT
Copyright/Patent Categories
Infringement Compensation
Eligibility Requirements
Infringement Exceptions
What's Infringement?
Quit
?

Figure 2. Hypertext Main Menu

Title:

Pseudoscience in Instructional Technology: The Case of Learner Control Research

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Pseudoscience in Instructional Technology: The Case of Learner Control Research

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Introduction

According to the latest version of the *Encyclopedia of Educational Research* (Alkin, 1992), there are currently "three major paradigms, or three different ways of investigating important aspects of education" (p. 620) in use by educational researchers (Soltis, 1992). These paradigms are described as:

- the positivist or quantitative paradigm,
- the interpretivist or qualitative paradigm, and
- the critical theory or neomarxist paradigm.

Soltis (1992) concludes that these paradigms currently coexist within the educational research community "in a state of tolerance and struggle" (p. 621). Some view the three paradigms as necessary to yield a full and complete picture of educational phenomena (cf., Salomon, 1991) whereas others regard them as incompatible (cf., Cziko, 1989, 1992), or as Kuhn (1970) would put it, incommensurable.

There is another perspective, espoused by Yeaman (1990) among others, that educational research (along with the other behavioral sciences) is what Kuhn called pre-paradigmatic. According to this perspective, educational research lacks the components of a Kuhnian research paradigm such as strong theory, valid measurements, unambiguous research designs, and reliable analytical processes.

Scientific research that is conducted without the structure of a supporting scientific paradigm should be labeled "pseudoscience" in that such research is false, deceptive, or sham science. The title of this paper is meant to put forth the thesis that some, perhaps most, research in the field of instructional technology is pseudoscience. It is beyond the scope of this paper to provide a comprehensive critique of the complete spectrum of research in the field of instructional technology. Instead, this paper presents a critique of that type of instructional technology research that is based upon what Soltis (1992) called the positivist or quantitative paradigm. More specifically, this paper focuses on a critique of a body of quantitative inquiry known in the field as "learner control research" (Steinberg, 1977, 1989).

Caveats

Before presenting a critique of learner control research, a few caveats are necessary. First, calling instructional technology research "pseudoscience" may seem overly harsh because it suggests that the people engaged in this research are corrupt. The following critique should in no way be interpreted as suggesting that the authors of the studies reviewed have engaged in any wrong-doing.[1] Instead I believe that they have followed powerful, albeit misguided, dictates to be scientific in the same way that older, more established sciences, are scientific. The desire to be scientific is endemic in our field and many closely related educational and psychological fields. This desire has many motivations, not the least of which is survival in a "publish or perish" academic culture (Yeaman, 1990).

Second, this critique is not about the debate between the merits of basic versus developmental research. A more serious problem in our field is that so much of the research that is supposed to be basic subscribes to the concepts, procedures, and analytical schemes of positivist, quantitative inquiry without meeting the theoretical and statistical requirements of that paradigm (Orey, Garrison, & Burton, 1989). In short, the problem is really one between valid and invalid research, or as described in this paper, science and pseudoscience.

Third, this critique, while not wholly original, should not be viewed as redundant, as was suggested by one of the reviewers of this paper. Although many critiques have been made of positivist inquiry in education in general (cf., Cziko, 1989, 1992; Phillips, 1987) and instructional technology in particular (cf., Clark, 1989; Reeves, 1986, 1989), studies of this type continue to be pervasive. Indeed, hardly an issue of the research journals in our field (cf., *Educational Technology Research and Development*, *Journal of Computer-Based Instruction*, *Journal of Research on Computing in Education*) appears without one or more reports of these types of studies.[2]

Learner Control

Learner control is defined as the design features of computer-based instruction[3] (CBI) that enable learners to choose freely the path, rate, content, and nature of feedback in instruction. Learner control is contrasted with "program control," i.e., design features that determine the path, rate, content, and feedback in instruction for learners. Learner control and program control represent a continuum of learner latitude that varies widely both within and between different instances of CBI.

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[1] Of course, only the most naive person would maintain that there is no corruption involved in instructional technology research just as there is in other types of scientific and pseudoscientific inquiry. It is not unusual to find out that scientists in the "hard" sciences as well as medicine, representing highly respected research institutions, have faked data or intentionally misinterpreted findings (Sykes, 1988). This no doubt occurs in our own field as well.

[2] This is hardly surprising given that how people conduct research "is based largely on the skills and ideas that are tacitly transmitted during what could be called a scientist's apprenticeship, in graduate school for example" (Bohm & Peat, 1987, p. 52). Many members of the tenured generation of instructional technology faculty who dominate the teaching of research methods in instructional technology graduate programs were schooled in positivist methods and may be unfamiliar with or uncomfortable with alternative approaches.

[3] Computer-based instruction is used rather loosely in this paper to include a wide range of interactive learning systems, ranging from a simple tutorial to a complex learning environment.

Proponents of CBI claim that CBI allows students to be in control of their own learning, and further, that being in control of learning results in greater achievement. Although this popular belief is often debated, the research evidence for and against these claims is extremely weak because, as documented below, inappropriate research methods have been used to investigate issues of learner control. A major thesis of this paper is that most of the learner control research currently reported constitutes "pseudoscience" in that it fails to meet the major theoretical and methodological assumptions underlying accepted research methodologies within the positivist, quantitative paradigm (Orey et al., 1989).

Given the inadequacy of the research conducted to date, it should not be surprising that research support for learner control is inconsistent. Steinberg (1977, 1989) sums it up as follows:

> Learner control sometimes resulted in greater task engagement and better attitudes, but not necessarily in greater achievement. In some instances learner control led to worse performance than computer control. While many students were motivated by learner control, others were indifferent to it. Aptitude and trait-treatment research yielded no definitive conclusions about learner control (Steinberg, 1989, p. 117).

Ross and Morrison (1989) conclude, "research findings regarding the effects of learner control as an adaptive strategy have been inconsistent, but more frequently negative than positive." Ross and Morrison claimed that at least part of the problem may be insufficient precision in defining just what is meant by "learner control" in various studies, and that learner control probably is not "a unitary construct, but rather a collection of strategies that function in different ways depending on what is being controlled by whom."

Problems with Definitions of Learner Control

Learner control is a concept that seems to mean something very clear and important, but it is so loosely defined in practice as to mean very little. Of course, in the scientific sense, learner control is a construct. A construct is a concept that has been intentionally synthesized on the basis of observation and/or theory to represent an idea or a phenomenon. As a scientific construct, we must be concerned with how learner control is defined and measured.

Learner control has been one of the most heavily researched dimensions of CBI in recent years (Steinberg, 1989). Figure 1 illustrates the learner control dimension in CBI ranging from complete program control to unrestricted learner control.

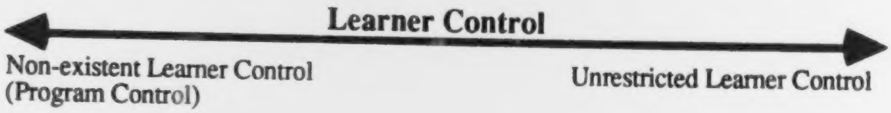

Figure 1. Learner control dimension of CBI.

Upon first consideration, learner control may seem like a simple concept in that it refers to the options in CBI that allow learners to make decisions about what sections to study and/or what paths to follow through interactive material. However, more careful consideration indicates that learner control is a very complex issue. For example, whenever learner control is defined, we must ask ourselves what is the learner controlling. In some cases, it may simply be the rate or order of screen presentations. In other cases, it may involve the activation of multiple microworlds and support systems within a complex learning environment in which the learner virtually authors his/her own CBI.

The "control of what" question is a critical one if we ever wish to have any meaningful impact on the design of CBI (Ross & Morrison, 1989). The finding that learner control of context for examples is effective in one setting and another finding that learner control of amount of review is effective in another setting provides little basis for linking these two types of learner control into a meaningful prescription for design of CBI. Even less guidance is provided for linking the dimension of learner control with other critical dimensions of CBI, e.g., structure.

Hannafin (1984) needed eight qualifying statements to support the application of learner control, and the recent research of Ross and Morrison (1989) and others indicates that even more specific qualifiers may be needed to clarify the effectiveness of learner control in different contexts. Can such complex statements be logically integrated with equally complex explications of other relevant variables to provide a clear basis for interactive design decisions? When do such complexities begin to exceed the human conceptual capacity to deal with seven plus or minus two variables at one time? Or are we in the situation that Cronbach (1975) so eloquently described of not being able to pile up generalizations fast enough to keep up with the process of learning?

It seems that researchers in instructional technology have come to use terminology such as learner control without sufficiently examining the meaning and implications of the construct. It is almost as if the mere utterance of a term like learner control brings it into meaningful existence. However the philosopher Alfred Korzybski (cited in Bohm and Peat, 1987) describes the danger of this way of thinking. Korzybski noted that our observations of the world around us are limited both by the frailties of our perceptual senses and our existing knowledge that shapes our interpretation of sense data. Further, he maintained that every kind of thought conceived as a result of observations is an abstraction that reveals only a limited view or slice of reality as we perceive it. Words or concepts in turn are abstractions of thought, and as such, fail to capture the complete essence of a thought. Consciously constructed concepts such as "learner control" are even further removed from our sense data, thoughts, and concepts. Our measures of scientific constructs represent yet another layer of abstraction, and the mathematics and statistics with which we analyze the data collected with our measures introduce additional abstraction. Finally, even more abstraction is required to go back down through the chain of abstractions to relate statistics to conclusions about the nature of reality.

All this, of course, is the very "stuff" of science. Well-established sciences such as physics deal with these very same problems. The solution of these problems in physics required the development of a series of scientific paradigms, one replacing the other with a more or less cohesive infrastructure of tacit beliefs and methods. The construction of paradigms in physics did not occur overnight, and some maintain that they are far from settled (cf., Regis, 1987). For example, the concept of atoms was around for thousands of years before it was considered seriously. Today, the commonplace understanding of atoms as tightly compacted concoctions of electrons and neutrons has yielded to a concept of atoms containing vast volumes of empty space sparsely populated by subatomic particles of many kinds (Pagels, 1988).

As noted above, this is not the first paper to suggest that instructional technology research and educational research in general suffer from a lack of well-established paradigms (cf., Yeaman, 1990). However, being "pre-paradigmatic" is not necessarily an undesirable state. There are at least two perspectives on this. Kuhn (1970) maintained that even the most established sciences such as physics have had a pre-paradigm stage, and that most contemporary social sciences are still at that stage. Kuhn wondered why social science researchers worry so much about whether they are really scientists:

> Inevitably one suspects that the issue is more fundamental. Probably questions like the following are really being asked: Why does my field fail to move ahead in the way that, say, physics does? What changes in technique or method or ideology would enable it to do so? These are not, however, questions that could respond to an agreement on definition. Furthermore, if precedent from the natural sciences serves, they will cease to be a source of concern not when a definition is found, but when the groups that now doubt their own status achieve consensus about their past and present accomplishments. (pp. 160-161)

Kuhn's emphasis on reaching consensus within a paradigm is intriguing. As instructional technologists, we are far from agreement regarding our past and present achievements. Reflecting the larger debate occurring among educational researchers of every kind, some instructional technologists view the past several decades of "media research" as having extremely limited value (cf., Clark, 1989). Others prefer to salute generations of previous research in instructional technology as laying the foundations for present day inquiry (cf., Ross & Morrison, 1989). However, if we must come to agreement concerning these issues before we can become "scientific," I would hope that we remain in the controversial pre-paradigmatic stage for some time to come.

Another perspective on the pre-paradigmatic stage is provided by two physicists, David Bohm and F. David Peat (1987). They maintain that over-emphasis on paradigmatic purity is to blame for much of the fragmentation in physics and other "hard" sciences. They maintain that a paradigm can be, and often is, detrimental to the creativity that underlies authentic inquiry. They claim that Kuhn is often misinterpreted as supportive of paradigm changes. Bohm and Peat argue that Kuhn actually viewed paradigms not as fundamental theories, but as "a whole way of working, thinking, communicating, and perceiving with the mind" (p. 52). Bohm and Peat regard the tacit or unconscious consent that pervades a given paradigm as exacting too heavy a price on the mind and the senses, shutting down the imagination and playfulness that the mind requires for meaningful inquiry. If achieving the status of a scientific paradigm means that we must sacrifice some of our creativity, I would prefer to remain pre-paradigmatic for a long time to come. We need creativity above all else. As Robert Ebel, a past president of the American Educational Research Association (cited in Farley, 1982) pointed out, ".....it (education) is not in need of research to find out how it works. It is in need of creative invention to make it work better" (p. 11).

Returning to the difficulty of defining learner control, at least part of the problem stems from the lack of an infrastructure of tacit understandings and methods to support this construct. In other words, we lack a scientific paradigm to guide research regarding learner control. However, as described below, this has done little to dampen the ardor of researchers in our field.

Problems with Learner Control Research

As indicated in the reviews by Ross and Morrison (1989) and Steinberg (1989), increasingly large numbers of research studies have been carried out to investigate the relative effectiveness of learner control. These investigations are focused on isolating the attribute or dimension of CBI called learner control and estimating its effectiveness in a variety of implementations (e.g., learner control with advisement versus learner control without advisement.) However, learner control studies have often led to no significant results in terms of the predicted main effects (cf., Kinzie & Sullivan, 1989; López & Harper, 1989; McGrath, 1992; Ross, Morrison, & O'Dell, 1989; Santiago, 1990). In fact, technical and methodological flaws largely invalidate these studies.[4]

First, it is clear that the instructional treatments used in these studies are usually far too brief to provide learners with sufficient experience for learner control variables to be "actualized." Kinzie and Sullivan (1989) reported that mean completion times for the experimental and control CAI lessons were 29 minutes, four seconds for the former and 29 minutes, six seconds for the latter, and López and Harper (1989) estimated that their CBI lesson treatment was "approximately 30 minutes in length." The treatments experienced by the students in the Ross, Morrison, and O'Dell study (1989) averaged between 25 and 30 minutes, and the students in the Santiago (1990) study averaged 30 minutes in the actual CBI lesson after a 15-20 minute orientation to the computer presented by the researcher. McGrath's (1992) students averaged only 13 to 17 minutes in their hypertext, computer-assisted instruction, no-choice CAI, or paper treatments.

Cronbach and Snow (1977) cautioned that ten or more separate interactive sessions were necessary to acquaint students with innovative instructional treatments. How can a dimension as complex as learner control be expected to have an effect in one session treatments lasting less than an hour? Suppose that a medical researcher was investigating the effects of an aspirin regimen on subsequent heart disease. The medical researcher might be interested in varying regimens of aspirin (one a day versus one every other day), but he/she would not look for the effects of administering a single aspirin on one occasion. And yet, we seem to be willing to place students in an analogous situation vis á vis learner control and expect meaningful results.

Second, there is a lack of consequential or relevant outcome measures in many media replication studies. Kinzie and Sullivan employed CAI lessons on solar energy and tarantulas, subjects not clearly articulated with their regular science curriculum. Although the seventh and eighth grade students in the López and Harper (1989) study were told that their grades would be reported to their teacher, the thirty minute lesson on insects was unrelated to their normal curriculum. The undergraduate teacher education student "volunteers" in the Ross, Morrison, and O'Dell (1989) and the Santiago (1990) studies received "credit" toward course grades for participating in the research, but the content subjects were only indirectly related to the courses in which the students were enrolled. McGrath's (1992) subjects were also undergraduate teacher preparation students enrolled in a media course, but the subject of the treatment lesson involved the mathematics of determining surface areas of hollow figures.

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[4] The five studies selected for this critique are representative of a larger collection of similarly flawed studies. A comprehensive analysis of available learner control studies is underway.

Subjects in learner control research should be engaged in learning that is personally meaningful and that has real consequences for them. Further, volunteer subjects learning content unrelated to their education or training needs or interests are inappropriate because this practice introduces unacceptable threats to internal and external validity (Isaac & Michael, 1971). It is ironic that so many learner control studies utilize researcher-created interactive materials when a number of large scale interactive learning systems are available. Examples include *Macintosh Fundamentals*, an interactive videodisc training course developed by Apple Computer, Inc. (1990) and *Illuminated Books and Manuscripts*, a set of five interrelated educational multimedia programs produced by the IBM Corporation (1991). Finding situations in which these and similar large scale programs are used in realistic contexts may be challenging for researchers, but the alternative compromises exact too great a price.

Two other concerns are small sample sizes and large attrition rates that leave some cells in the analyses with inadequate numbers of subjects. Another problem concerns dropping subjects from the analyses who have correctly answered all questions within the interactive lessons, as was done in the Kinzie and Sullivan (1989) research. Without missing a correct response, these students clearly had no opportunity to experience learner control or program control over review. And what about students who only missed one or two of the fifteen questions interspersed into the CAI lessons? Did they "experience" the treatment variables?

Clark (1989) is correct in suggesting that many of these and similar studies in instructional technology are conceptualized without an adequate understanding of all the related theoretical assumptions and pertinent research findings. As a result, little guidance is provided for linking the dimension of learner control with other critical dimensions of CBI, e.g., screen design or feedback. The conclusions presented in some of the studies cited above are nothing less than convoluted. The irony is that in reading any single one of these complex "explanations" of why significant findings were not found, the reader may find the researcher's arguments somewhat plausible. The real complexity arises when one tries to make sense of these explanations across the various research reports. In the end, we must ask ourselves how such complex statements can be logically integrated with equally complex explications of other relevant variables to provide a clear basis for CBI design decisions (Reeves, 1992).

What should be done?

This paper presents evidence that learner control research studies are flawed in terms of sample sizes, treatment duration, content selection, and other theoretical and methodological issues to such an extent that the research has little value. (The criticisms of learner control research described above could easily be extended to other areas of research in instructional technology, e.g., studies on screen design issues.) These flaws and fundamental problems arising from a lack of a scientific paradigm to guide research in this field yield a conclusion that the positivist research we are currently conducting is largely pseudoscience.[5]

However, it is not enough to critique research in our field. I wish to suggest some new directions. First, there is a serious need for graduate students and researchers in our field to develop an improved understanding of contemporary philosophy of science. Courses in the philosophy of science, preferably taken outside Colleges of Education, would expose researchers to a larger spectrum of approaches to inquiry than found in many traditional courses emphasizing experimental and quasi-experimental designs. Phillips (1987) speaks to this need, "New approaches to the design of evaluations of educational and social programs are being formulated that make the "true experiment" seem like a lumbering dinosaur, yet some folk persist in thinking that dinosaurs are wonderful creatures" (p. viii).

Second, I believe instead of worrying about whether or not we have a paradigm in which to conduct research in instructional technology, we should begin to address some of the questions that Kuhn (1970) suggests underlie our concerns. Important questions include: Why hasn't our field moved ahead as others have? What techniques, methods, or ideologies will enable us to progress? In other papers (Reeves, 1986, 1990, 1992), I have suggested that we explore alternative approaches to research in our field such as computer modeling (Pagels, 1988) and formative experiments (Newman, 1990). These alternative approaches address systemic rather than analytic issues in educational contexts. (Salomon (1991) provides an excellent overview of the differences between systemic and analytic approaches.) The value of systemic approaches are that they provide the basis for theory and hypotheses that may be investigated using analytic procedures. Salomon (1991) summed the issue up this way, "Without observations of the whole system of interrelated events, hypotheses to be tested could easily pertain to the educationally least significant and pertinent aspects, a not too infrequent occurrence" (p. 17). Such is the case in learner control research.

Third, the time to explore alternative research paradigms in our field has never been more critical. Instructional technology as a field may be in danger of becoming irrelevant. One of the field's major components, instructional design (Briggs, Gustafson, & Tillman, 1991), is under attack in several quarters (cf., Carroll, 1990; Gery, 1991). Further, some of the most advanced learning environments are being created by cognitive psychologists and others in fields outside instructional technology, such as the *Jasper Series* at Vanderbilt University (Cognition and Technology Group at Vanderbilt. 1992).

Exploring alternative research paradigms might also encourage us to undertake more of the "creative invention" that Ebel claimed is needed in education (cited in Farley, 1982). This may require changing the reward structures in traditional academic settings. It is pathetic that the creation of an interactive learning system with the potential to change the lives of hundreds, even thousands of people, is given less worth in some academic settings that a "research" paper published in the most arcane journal.[6]

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[5] Some, perhaps many, will disagree with this conclusion. One rebuttal of the thesis that learner control research is pseudoscience might involve making a case that the example studies cited are simply poor studies, and that studies that eliminate the flaws in these studies by incorporating substantive treatments over a meaningful period of time with large samples in practical contexts would be "real" science. However, such a defense does not address the problems of defining learner control as described above.

As noted earlier in this paper, Soltis (1992), writing in the *Encyclopedia of Educational Research* (Alkin, 1992), describes three major paradigms for inquiry in education, the positivist (quantitative), the interpretivist (qualitative), and the critical theorist (neomarxist). I don't know enough about the neomarxist paradigm to comment on its applicability in our field. However, I do believe that we could benefit greatly from well-conceived qualitative inquiry in our field. I recommend that we call a moratorium on the types of quantitative studies described in this paper, replacing them with extensive, in-depth efforts to observe human behavior in our field and develop meaningful theory that may later be susceptible to quantitative inquiry. I am not suggesting that we eliminate quantitative, positivist inquiry altogether. After all, as Salomon (1991) describes, quantitative (analytic) and qualitative (systemic) inquiry may have complementary functions. However, the qualitative, interpretivist paradigm should proceed the quantitative if we are to identify meaningful hypotheses to investigate empirically.

The difficulty, of course, is assuring that the interpretivist, qualitative inquiry is well-conceived and rigorously applied. There is a danger that researchers in our field will adopt qualitative methodologies to inquiry as poorly as they have quantitative methods. No one becomes an ethnographer or participant observer overnight (Preissle, 1991). Case studies and ethnography can be as poorly conceived and conducted as any other methods (Levine, 1992). It has been observed that some physics graduate students and young physicists gravitate toward research in "cutting edge" topics such as subatomic phenomenon and tabletop fusion not so much because these are the most important topics, but because it is so much easier to get to the frontiers of these areas of physics than it is to develop the background in older areas of inquiry such as solid-state physics. It would be a shame if researchers in our field jumped onto the qualitative bandwagon without adequately preparing themselves for the journey.

What would be the value of expanding observation and reflection in our field? Consider the following quote from the expedition log of John Steinbeck (1941), the noted American author who was also a marine biologist:

> We knew that what we would see and record and construct would be warped, as all knowledge patterns are warped, first by the collective pressure and stream of our time and race, second by the thrust of our individual personalities. But knowing this, we might not fall into too many holes - - we might maintain some balance between our warp and the separate things, the external reality. The oneness of

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[6] The pressure to publish or perish is especially powerful for doctoral students and new faculty members. In light of this, one reviewer of this paper suggested that criticisms aimed at research conducted by doctoral students and new faculty should not be as strong as presented in this paper. However, I think that holding the research of graduate students and new professors to a lower set of standards would be ill-advised. First, it is insulting to their often remarkable capabilities. Second, students and faculty members do not conduct research in a vacuum, unaided by the support and review of their colleagues. This is especially true for doctoral candidates who have the combined research expertise of an entire faculty committee to guide their research efforts. Third, the research conducted by students and new professors constitutes a very large portion of the research carried out in our field and must be rigorously assessed if the field is to advance.

> these two might take its contribution from both. For example: the Mexican sierra has 'XVII-15-IX' spines in the dorsal fin. These can easily be counted. But if the sierra strikes hard on the line so that our hands are burned, if the fish sounds and nearly escapes and finally comes in over the rail, his colors pulsing and his tail beating the air, a whole new relational externality has come into being - - an entity which is more than the sum of the fish plus the fisherman. The only way to count the spines of the sierra unaffected by this second relational reality is to sit in a laboratory, open an evil smelling jar, remove a stiff colorless fish from formalin solution, count the spines, and write the truth 'D. XVII-15-IX." There you have recorded a reality which cannot be assailed - - probably the least important reality concerning either the fish or yourself. It is good to know what you are doing. The man with his pickled fish has set down one truth and has recorded in his experience many lies. The fish is not that color, that texture, that dead, nor does he smell that way. (p. 2)

Do we not now have too much in common with the technician in the lab enumerating the spines of a dead fish when we carry out the type of quantitative studies described above? Further, do we have too little in common with the fisherman struggling with the rocking of the boat, the whipping of the wind, and the thrashing of the fish on the line? Fifty years of quantitative inquiry in instructional technology has provided us with precious little to guide our efforts to enhance education and training. Let us try some other ways.

Author's Notes

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Title:

Qualitative Research Methods Workshop:
An Introduction
Definitions
Readings on Qualitative Research: An Annotated Bibliography

Authors:

Rhonda S. Robinson
Marcy P. Driscoll

Qualitative Research Methods: An Introduction

Introduction

Emerging as a separate field in the 1940's, Educational Technology drew upon theory bases from psychology, learning, and perception. The field was derived primarily from behavioral and cognitive psychology, and consequently based its seminal research on strict experimental models appropriate to the early questions and hypotheses developed. Media was tested experimentally, and found (at the time) to be effective.

In the forty years of research that followed, the same experimental paradigm predominated. New media were tested against old, characteristics of learners and specific media were compared, and relationships between learners and media were explored, all using various accepted experimental designs.

More recently, the field has broadened its definition to include instructional design, media analysis, and learner attitudes among other topics. Researchers are asking a variety of new questions, many of which would be difficult to examine using traditional experimental methods.

Background and Rationale

Currently, most of the published scholarship in educational technology has been based upon experimental and descriptive studies. The leading researchers, those who train future scholars in research methods, have only recently begun to accept a full range of research methodologies for educational technology. Consequently, educational technology journals publish few studies based upon non-experimental designs. Since reports of alternate methodologies are few, researchers in educational technology have only the models of research reports in other fields to assist them in research design and reporting.

The experimental "bias" in educational technology has been questioned by many researchers seeking to expand the areas of scholarship in the field. Becker (1977) recommended alternate methodologies to approaching educational technology research. Cochrane, et al. (1980) suggested that researchers base new areas of inquiry on "the ethnography of situations in which people use visual materials (an anthropological approach)" (p. 247). They stressed the importance of recognizing that visual learning is a cultural phenomenon and should be studied with techniques and analyses appropriate to cultural processes. Heinich (1984) in his N.I.E. funded ten year review paper encouraged researchers to engage in more "naturalistic" inquiry. "Through the use of naturalistic inquiry, I am sure we will discover important factors ... that have been ignored too long ..." (p. 84). Heinich also argued that such research should be encouraged in dissertation work and should be more disciplined and more perceptive than experimental studies.

Alternative methodologies would lead the field of educational technology to new questions, and to often ignored areas such as the impact of educational technologies on social relationships and educational institutions. Kerr (1985) suggested that methods drawn from sociology, policy sciences, and anthropology could "shed new light on problems that have traditionally been approached using psychological research methods" (p. 4). Kerr felt that asking new questions in less traditional ways was critical to the future of education.

This growing need for studies that do not appear to fit the traditional experimental paradigm has been recognized. Yet training of researchers continues in the traditional vein. Coursework provides extensive knowledge and experience primarily in experimental research studies (of the traditional, single variable, hypothesis testing variety).

The overall goal of this qualitative research workshop was to balance that training and to prepare students to undertake non-traditional, yet still rigorous research. The specific purposes that supported this goal were as follows:

1. To acquaint students with the realm of noncausal naturalistic inquiry and its relation to hypothesis testing research, in the context of philosophy of science;
2. To enable students to raise noncausal issues in development and evaluation and discuss ways of investigating these issues via nontraditional paradigms;
3. To enable students to analyze ongoing research in education that does not conform to the traditional paradigms;
4. To give students practice in conceptualizing research questions that do not conform to the traditional paradigms and in designing appropriate studies for investigating these questions; and
5. To provide a forum for proposing and discussing additional and alternative types of research that may appear warranted by growing research needs in education.

Workshop topics included:

- Background to Qualitative Research-Why and How it has been taught
- Types of Qualitative Research (among many)-Definition/Examples
  - Case Study
  - Ethnography
  - Grounded Theory/Phenomenology
  - Narrative Inquiry
  - Others (Semiotic, Critical Inquiry)
- Topics for Educational Technology research - Selecting appropriate method
- Data Gathering Techniques
  - Interview
  - Observation
  - Participant-Observation
  - Document Review, Literature analysis
    - -Practice data gathering activity and discussion
- Problems and Concerns
  - Analysis
  - Writing and reporting
  - Validity and Reliability
  - Absence of "Rules" for reporting
- Questions and Discussion

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QUALITATIVE RESEARCH: DEFINITIONS

Case Study: a research strategy used "when 'how' or 'why' questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context" (Yin, 1989, p. 13).

Ethnography: "the art and science of describing a group or culture" (Fetterman, 1989, p. 11).

Holistic ethnography: used "to describe and analyze all or part of a culture or community by describing the beliefs and practices of the group studied and showing how the various parts contribute to the culture as a unified, consistent whole" (Jacob, 1987, p. 10).

Ethnography of communication: also referred to as "microethnography" and "constitutive ethnography," this strategy focuses "on the patterns of social interaction among members of a cultural group or among members of different cultural groups" (Jacob, 1987, p. 18).

Cognitive anthropology: also called "ethnoscience" and "new ethnography," this method is used to study culture in mentalistic terms. "The approach seeks to understand participants' cultural categories and to identify the organizing principles that underlie these categories" (Jacob, 1987, p. 22).

Grounded Theory: the development of theory "from the bottom up (raather than from the top down), from many disparate pieces of collected evidence that are interconnected" (Bogdan and Biklen, 1992, pp31-32).

Phenomenology: a process of inquiry used to "understand the meaning of events and interactions to ordinary people in particular situations....Phenomenologists believe that multiple ways of interpreting experiences are available to each of us through interacting with others, and that it is the meaning of our experiences that constitutes reality" (Bogdan and Biklen, 1992, p. 34).

Critical Inquiry: a mode of inquiry that "focuses on criticism in the sense of art and literary criticism models within the humanities" (Hlynka and Belland, 1991, p. 6).

Semiotic Approach: an approach to inquiry that transcends objectivist and relativist perspectives by recognizing inquiry into meaning as distinct from inquiry into truth. Thus, "rather than pretending that a theory explains research findings once and for all, educators need to work just as hard on determining how to understand these results in relation to the vast and complex network of codes that underlie and inform the educational and larger culture" (Shank, 1992,. p. 203).

Policy Research: "the process of conducting research on, or analysis of, a fundamental social problem in order to provide policymakers with pragmatic, action-oriented recommendations for alleviating the problem" (Majchrzak, 1984, p. 12).

Participatory Action Research: a research strategy in which "some of the people in the organization or community under study participate actively with the professional researcher throughout the research process from the initial design to the final presentation of results and discussion of their action implications" (Foote Whyte, Greenwood, and Lazes, 1991, p.20).

[Please note that these approaches to qualitative inquiry are not all mutually exclusive.]

A.E.C.T. 1993
Robinson/Driscoll
Qualitative Research Workshop

Readings on Qualitative Research
An Annotated Bibliography

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All of the books listed below involve discussions of qualitative research in general and ethnography in particular. The most beneficial aspect of each book is highlighted. Ultimately this information will be utilized to describe and support my intended study and research design.

Smith, M. & Glass, G. (1987). Research and evaluation in education and the social sciences. New Jersey: Prentice-Hall.

This book provides a nice overview of qualitative research. The authors note that "the aim of naturalistic research is to understand the persons involved, their behavior and perceptions, and the influence of the physical, social, and psychological environment or content on them" (Smith & Glass, 1987, p. 257). Included in the review is a differentiation between qualitative and quantitative research.

The most relevant information included in the book is a method to critique qualitative research. The authors note that because of the variety in qualitative studies specific guidelines cannot be assigned. However, certain issues regarding evaluation of qualitative research can be applied.

These issues are:

1. Time spent collecting data - This is a primary control that needs to be assessed. If time is restricted more data needs to be collected from alternate sources.
2. Access to data - The quality of the relationship determines the ability to access data.
3. Naturalness of the data - The ideal study portrays a case as realistically as possible.
4. Researcher self-criticism - The researcher should identify his preconceptions and biases.
5. Logical validity - There should be carefully reasoned connections between the descriptive data if conclusions are drawn.
6. Confirmation - Systematic efforts to check hypotheses with alternatives should be made.
7. Descriptive adequacy - Methods of conducting the study should be adequately and thoroughly described.
8. Significance - The study should address a theoretically important question in a manner which can be answered.

Hutchinson, S. (1988). Education and Grounded Theory. In Sherman, R. & Webb, R. (Eds.). Qualitative research in education: Focus and methods. London: The Falmer Press.

This book consists of a series of essays that address different aspects of qualitative research. Essays include topics related to the historical, philosophical, educational and biographical aspects. However, the article by Hutchinson discusses grounded theory "which is concerned with theory generation, rather than verification, through discovery of what the world appears to be to participants and through an analysis of those perceptions, of the basic social processes and structures that organize the world" (p. 3). Hutchinson (1988) notes that "educators need the freedom offered by grounded theory to intelligently and imaginatively explore the social psychological consequences of school life" (p. 127).

The essays describe the method for conducting this research. The researcher collects, codes and analyzes data at the same time. The importance and manner of coding the data is identified. It is essential to understand the nature of data collection in order that emerging concepts can be identified and clarified.

This would be an essential essay to review when establishing the research design. "Rich and complex data can be analyzed systematically, yielding a final product that is theoretically sound and can be put to practical use" (p. 138).

Eisner, E. (1991). The enlightened eye, qualitative inquiry and the enhancement of educational practice. New York: Macmillan Publishing Co.

This is an excellent book which has as its emphasis the relationship between qualitative thought and human understanding. The author thoroughly analyzes qualitative inquiry within the context of the educational setting. "If qualitative inquiry in education is about anything, it is about trying to understand what teachers and children do in the settings in which they work" (p. 11).

It would be difficult to identify an aspect of this text which would prove most relevant. The text addresses all aspects of qualitative research in a meaningful way. It could easily serve as a textbook on qualitative inquiry.

The last chapter identifies problems often faced by doctoral students utilizing this method for their dissertations. The author supports qualitative research for dissertations which investigate educational practice.

> The creation of new visions of educational inquiry can not only broaden the ways in which we study schooling, but even more important, can expand our conception of human cognition and help us develop new forms of pedagogical practice.

Sudman, I. (1991). Interviewing as qualitative research. New York: Teachers College, Columbia University.

This is an essential reference book for anyone considering interviewing as a means of data collection. The purpose of using interviews is described along with establishment and correct selection of participants.

A successful interview is not easily conducted. Therefore, the chapter on techniques is extremely beneficial. The author acknowledges that interviewing skills can be learned and developed. The concepts of listening skills, timing, clarifying and appropriate types of questioning are all discussed.

The author's purpose is to define the essential elements of an interview in order that the strength of this technique can be achieved. "In-depth interviewing's strength is that through it we can come to understand the detail of people's experience from their point of view" (p. 103).

Bogdan, R. & Biklen, S. (1992). Qualitative research for education. Boston: Allyn & Bacon.

This book serves as an introduction to qualitative research. It covers the historical evolution of this type of research and proceeds to address various kinds of qualitative research. One of the nicest aspects of this book is the author's use of examples to illustrate data analysis.

The chapter on writing up the research is very helpful. It addresses the problem of how to begin through getting started and actually completing the written manuscript. This would be especially helpful when attempting to write either a dissertation or research for publication.

Goetz, J. & LeCompte, M. (1984). Ethnography and qualitative design in educational research. San Diego: Academic Press, Inc.

This book deals strictly with ethnographic research in the educational setting. It begins with a detailed description of educational ethnography. The authors note that "the purpose of educational ethnography is to provide rich, descriptive data about the contexts, activities and beliefs of participants in educational settings" (p. 17).

The chapter which addresses the assessment of the research design is very helpful. A discussion of quality control, credibility, reliability, validity and evaluation of the design is included in this chapter. It would prove very useful in the development of the research design.

Eisner, E. & Peshkin, A. (1990). Qualitative inquiry in education. The continuing debate. New York: Teachers College Columbia University.

This book includes a series of essays that address the relevance of qualitative research in education. Most of the articles are centered around the topics of generalizability and validity, since these are aspects of qualitative research which are often subject to criticism.

However, the series of articles concerning ethical issues in qualitative research is of utmost importance. This is an area that is often not covered comprehensively in a standard textbook. The novice researcher, especially, needs to be aware of all of the ethical considerations which must be addressed. "... there is a multifaceted, overlapping complex of potential ethical issues in every dimension of their work that they need to become sensitive to if they are to be true to their commitment to a human science" (p. 296). It is essential to read these articles before initiating a research project.

Strauss, A. (1987). Qualitative analysis for social scientists. New York: Cambridge University Press.

This book deals primarily with the analysis of qualitative data. The one area that is covered more specifically in this book is the use of integrative diagrams as a means of making data come together. This proves useful as a method of sequencing data in order to analyze it fully.

The other interesting area of this book is the chapter of questions and answers. This chapter alone proves valuable to a neophyte researcher because it poses many questions that automatically come to mind.

Spradley, J. & McCurdy, D. (1972). The cultural experience, ethnography in a complex society. Chicago: Science Research Associates.

This book addresses the concept of ethnography. The explanations of ethnographic research are unique. The authors first explain the ideas of cultural meaning, experience and description. These chapters are easily understood.

However, the most relevant part of this book is the series of ethnographic case studies. These provide the reader with an understanding of the procedures for conducting ethnographic research.

In summary, the preceding bibliography covers the entire realm of qualitative research. Everything from the historical evolution to the present day criticisms has been addressed. It would be beneficial for anyone beginning a qualitative research project to review the books highlighting the aspects specific to the chosen research design.

Title:

What Motivates Graduate Students? A Descriptive Study

Author:

Stephen Rodriguez

What Motivates Graduate Students? A Descriptive Study

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National Convention, January 1993
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Abstract

This study sought to describe graduate students' opinions of selected learning activities encountered in large-group, teacher-led instructional contexts. The subjects, forty graduate students of instructional technology at a major western university, completed a questionnaire. The instrument asked subjects to rate each of ten alternative learning activities along five dimensions: frequency the activity is encountered; interest in the activity; effectiveness of the activity as a learning tool; motivational appeal of the activity; and last, desire for greater exposure to the given activity. Results indicated that lecture is the most frequently encountered activity, while also the least motivating and effective. Further, subjects indicated a strong preference for greater exposure to more active, challenging activities such as problem solving, case studies, and small group work.

Instructional design theory and models stress the criticality of engaging students in learning activities requiring overt performance. Current constructivist conceptions of the learning process, however, suggest that those activities which provide opportunity to utilize existing knowledge and experience will be most effective. Designers and teachers are challenged to select powerful, varied learning activities that will support higher-order learning outcomes and meaningful knowledge construction.

The present study was conducted to determine which kinds of learning activities certain graduate students find most meaningful, motivating, and effective. The study seeks to describe students' opinions regarding ten selected learning activities.

Method

Subjects

Subjects included 40 adult graduate students of instructional technology at a large university in Northern California.

Instrument and procedure

A questionnaire was designed and pilot-tested for the purpose of ascertaining subjects' opinions about selected learning activities, including the following: brainstorming, problem solving, case studies, lecture, structured note taking, games, role playing, responding to written questions, responding to oral questions, and small-group work. The activities were selected because they are consistent with the types of activities employed by the author in conducting graduate courses.

The seven-page instrument began with a cover letter explaining the intent of the study and a sample item. The body of the instrument was built upon a consistent series of items that was presented for each of the ten activities in question.

The format for each learning activity, as shown in Appendix A, was as follows: to begin, the given activity was identified and defined. The first three items asked for ratings on ten-point scales. The first item asked the subject to rate how often s/he encountered the activity; the second asked for a rating regarding interest in the given activity; the third item asked for a rating of the effectiveness of the activity as a learning tool. The fourth item asked whether the subject found the given activity motivating and required a "yes/no" response. It was followed by a space for comment. The fifth item asked if the subject would like to do the given activity more often. Finally, a prompt to provide written suggestions for improving the given activity was provided. At the end of the instrument, subjects could fill-in their own learning activities (not specified by the author) and answer the same series of questions for that activity.

The instrument was administered to two intact sections of an introductory instructional design (ID) seminar and to one intact section of an advanced ID seminar. The researcher began by briefly describing the purpose of the study and by guiding subjects through completion of the sample item. Subjects completed the instrument in silence over fifteen minutes prior to the start of their regular classes. Forty subjects responded to the questionnaire.

Results

Table 1 shows the means and standard deviations for the frequency ratings by activity. Lecture received the highest mean rating of 9.6 in terms of frequency while games and role playing tied for the lowest rating, with mean ratings of 4.4, respectively.

Table 1: Mean Ratings of Perceived Activity Frequency		
Activity	Mean	Standard Deviation
Brainstorming	6.0	2.6
Problem Solving	5.7	2.0
Case Studies	5.8	2.6
Lecture	9.6	1.5
Structured Notes	6.4	2.3
Games	4.4	2.3
Role Plays	4.4	2.4
Discussion/Prep'd Ques.	6.4	2.5
Oral Questions	8.0	2.0
Small Grp Work	7.1	2.1

Table 2 shows the means and standard deviations for interest ratings by activity. Brainstorming and small group work were rated as the most interesting types of learning activities with average ratings of 8.0, respectively. Problem solving and case studies were also highly rated. Conversely, subjects indicated that they found "lecture" as the least interesting kind of learning activity, as it had an average rating of 5.9.

Table 2: Mean Ratings of Interest in Activities		
Activity	Mean	Standard Deviation
Brainstorming	8.0	1.9
Problem Solving	7.8	1.6
Case Studies	7.9	2.0
Lecture	5.9	2.3
Structured Notes	7.5	2.1
Games	7.1	2.2
Role Plays	6.5	2.7
Discussion/Prep'd Ques.	6.9	2.2
Oral Questions	6.0	2.6
Small Grp Work	8.0	1.9

Table 3 indicates subjects' ratings of the effectiveness of the activities as learning experiences. They rated case studies as most effective, with this type of activity receiving an average rating of 8.5. Problem solving, case studies, small group work, and brainstorming also received high average ratings of 8.0 or more. Lecture received the lowest mean rating of 5.9, indicating that subjects see this type of "activity" as least effective of the given choices.

Table 3: Mean Ratings of Effectiveness as Learning Tool		
Activity	Mean	Standard Deviation
Brainstorming	8.0	1.9
Problem Solving	8.4	1.6
Case Studies	8.5	1.4
Lecture	5.9	2.0
Structured Notes	7.5	2.3
Games	7.2	2.3
Role Plays	7.2	2.2
Discussion/Prep'd Ques.	7.3	2.2
Oral Questions	6.7	2.5
Small Grp Work	8.2	1.7

Table 4 shows the proportions of the 40 subjects' responses to questions concerning whether they found a given activity motivating and whether they wished to "do the activity" more often. The "ns" option stood for "not sure" for those who were non-committal.

Results indicate that subjects find problem solving and case studies to be the most motivating of the activities considered. A proportion of .825 identified each of these as motivating. Conversely, subjects indicated that lecture was the least motivating activity at a proportion of .35. However, a proportion of ,375 expressed uncertainty as to whether or not they found a lecture to be motivating.

Subjects further indicated a preference for more problem solving activities, at a proportion of .775. Other activities to which they would like more exposure included case studies, brainstorming, and small group work.

Items at the end of the instrument allowed subjects to identify other learning activities not presented by the researcher and to answer the same series of question posed for the given activities. Respondents identified student presentations, feedback sessions with other students, individualized activities, independent study, field trips, expert lectures, simulations, and multimedia or computer-assisted presentations as other viable types of learning activities.

Discussion

The present study revealed that the surveyed graduate students do have definite opinions regarding the motivational appeal and effectiveness of various kinds of learning activities. It is interesting to note that while subjects found lectures to be unmotivating and ineffective, this type of activity is the one they most frequently encounter in their graduate courses. It seems safe to say, further, that lecturing is not an ideal means of furthering knowledge construction by students.

Table 4: Proportions of Motivational and Repetition Opinions by Activity

Activity	Is it motivating?			Do more often?		
	yes	no	ns	yes	no	ns
Brainstorming	.80	.10	.10	.675	.125	.20
Problem solving	.825	.025	.15	.775	.075	.15
Case studies	.825	.05	.125	.75	.10	.15
Lecture	.275	.35	.375	.175	.625	.20
Structured note taking	.50	.325	.175	.45	.35	.20
Games	.75	.125	.125	.575	.225	.20
Role playing	.60	.20	.20	.525	.275	.20
Written questions	.625	.20	.175	.575	.225	.20
Oral questions	.525	.35	.125	.375	.425	.20
Small group work	.775	.10	.125	.70	.20	.10

Subjects indicated a strong desire for more challenging learning activities such as problem solving, case studies, role playing, and brainstorming. Findings will guide the author in developing instructional strategies that incorporate activities that are both motivating and effective. Other s working with graduate students of instructional design or technology are encouraged to employ the question format presented in Appendix A toward determining their own students' preferences. Future studies of this sort will be more valuable as they engage greater numbers of subjects from diverse institutions in an effort to ferret out more generalizable findings.

Appendix A

BRAINSTORMING ***(A process for generating any and all ideas without criticism.)***

How ***often*** have you encountered this activity?

Never 1 2 3 4 5 6 7 8 9 10 Often

Rate your ***interest*** level in brainstorming activities.

Low 1 2 3 4 5 6 7 8 9 10 High

How do you rate brainstorming in terms of ***effectiveness*** as a learning tool?

Low 1 2 3 4 5 6 7 8 9 10 High

Do you find brainstorming activities ***motivating***? Yes __ No __ Not sure __

Why or why not? ____

Would you like to do this type of activity ***more often***? Yes __ No __ Not sure __

List on the back ***suggestions*** you have for improving a brainstorming activity.

Title:

Digitized Speech as Feedback in Computer-Based Instruction

Authors:

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Digitized Speech as Feedback in Computer-Based Instruction

We should not be surprised by the flood of educational products utilizing digitized speech currently moving through the home and school markets. From the time of Socrates, speech has been an important part of instruction. For most of history speech has been the primary mean of communicating content to the learner. Only recently has text in the form of books and other technologies been effectively utilized to increase the number of learners that can be reached and to provide a consistent delivery of information. Naturally then, the integration of speech into instructional software has great intuitive appeal, especially if it can be linked to text, graphics and animation.

While the phenomenon of talking software may now be upon us in full, it has been evolving for years. Several techniques for generating computer speech have existed since the 1970s. However, these early techniques were seldom utilized because of cost, equipment requirements or quality issues. Recent advances in hardware and software have made the use of digitized speech a practical option for many instructional applications.

Software designers and developers appear to believe that speech will make computer-based instruction (CBI) more attractive, more effective, and ultimately more marketable. They are rushing to integrate speech into a variety of products. Their motives for applying this technology, however, may be based purely on consumers' demonstrated eagerness to see, use and own the latest innovations.

There is little empirical research to indicate that educational gains can be achieved by simply incorporating speech in computer software. Decades of empirical research on the use of sound, music and speech in instruction (Brophy, 1981; Chiang, 1983; Cumming & McCorriston, 1981; Fleming, 1980; Haugh, 1952; Rulon & Others, 1943; Rysavy & Sales, 1991; Sanders, Benbasset & Smith, 1976) provide only limited guidance on how these features might be used in computer-based instruction. This guidance falls well short of identifying when speech is an appropriate component of CBI, the role it should perform, or the interface and operational support that a program should provide to ensure optimal learning.

Many questions that may inform decision about the utilization of speech in software remain unanswered. This paper reports on two studies conducted in an effort to help use better understand the role of digitized speech as feedback in CBI. (A third study in this line of research is being reported at this meeting by Michael D. Johnston.)

Study 1. The first study examined the use of familiar and unfamiliar voice feedback in two computer-based lessons designed to teach advertising techniques (propaganda techniques) to fifth graders. The role of the voice feedback was to provide knowledge of response, guidance and motivation during the practice portion of the instruction. (See figures 1-6 for examples of the screen displays from the computer-based lesson, the feedback types, and content of the feedback messages.)

The primary research questions addressed in this study were:

- Will the use of a feedback provider whom learners know influence their performance in the instruction, as measured by the posttest?
- Will the use of (1) voice with text or (2) voice with a speaker's image influence the learners' performance in computer-based instruction?
- Are there differences (e.g., use of optional buttons, achievement, time to complete) in performance that can be attributed to gender?

Study 2. The second study examined the effects of three types of feedback (1) spoken audio only, (2) printed and read (spoken), and (3) spoken by an animated character. These feedback types were substituted in the propaganda software used for the first study. (See figures 7-9 for examples of the screen displays from the computer-based lesson, the feedback types, and content of the feedback messages.)

The primary research questions were:

- Will the type of feedback (i.e., form of presentation - (1) spoken audio only, (2) printed and read (spoken), and (3) spoken by an animated character) effect performance?
- Will reading ability interact with performance as measured by posttest scores?

Literature Review

What is the role of speech in instruction? It would be difficult to deny that speech can play a central role in the delivery of instruction. Most modern models of instruction assume the extensive use of spoken or written words. For example, each of the events of instruction (Gagne, Briggs & Wager,1992), from informing the learner of the objectives to enhancing retention and transfer, can be accomplished at some level through spoken words.

The power and influence of the spoken word is equally difficult to deny. The effectiveness and impact of speech in such roles as the delivery of content, feedback and motivation in classroom instruction are well documented (e.g., Brophy, 1981, 1986).

Salomon (1979, 1985) argues that research on the effectiveness of media must look at the most essential characteristics of symbol systems being utilized. In software that utilizes digitized speech, Brophy's work on the impact of teachers' comments indicates that these essential characteristics are the familiarity of the source, the nature of the learners relationship with the source, and the attitude communicated through tones and inflections in feedback to the learner.

What do we know about the effects of speech (and other audio) in computer software? Researchers have expressed concern over techniques and strategies for the use of speech in CBI. Sanders, Benbasset and Smith (1976), for example, argue that for speech to add significantly to learning, it must not "merely take the place of a hard-copy manual or of printed text on a computer terminal." For example, one method of adding value to the use of audio might be to personalize the software. Personalization strategies have been shown to increase the effectiveness of CBI (Ross, 1983, Ross & Anand, 1987).

Research on the use of speech in CBI has had mixed results. Research conducted with young children learning phonics and vocabulary (Sales & Johnson, 1991) found no achievement or attitude differences for students in several treatments involving different levels of speech and "motivational" sound. The authors suggest several explanations including the low level of students' metacognitive skills, and the redundant presentation of critical information through text.

Two research studies examining the different uses of audio in computer-based instruction were conducted with special needs students (Chiang, 1983, Wiener, 1991). These studies had dramatically different findings. Chiang found audio designed to reward and motivate students was actually detrimental to learning. He argued that audio served as a distractor, causing students to require more study time to achieve the same level of learning. Wiener, however, found significant achievement effects when using computer generated speech to teach word recognition to mentally handicapped junior high school students.

In summary, speech can be a critical component of instruction. It appears to be particularly valuable as a means of communication between the teacher and the learner. Much of the communication results from when and how the message is delivered. These characteristics of the discourse may be essential to the learning outcomes.

Speech and other auditory elements of CBI have had mixed success in a number of research studies. Our limited understanding of these findings is in part due to the small amount of research that has been conducted. This, in turn, can be traced to the rapid changes technologies and the fact that the commercial application of speech in CBI has only recently become practical.

Study One

Participants. The subjects who voluntarily participated in this study were 100 fifth grade students from a suburban Minneapolis elementary school. All of the students had regular contact with computer-based instruction prior to the study.

Instructional materials. The software, which provided instruction on propaganda techniques used in advertising, is based on the software used by Carrier and associates (see Carrier &Williams 1988; Carrier, Davidson and Williams, 1985). The new version, was designed to take advantage of the graphic and sound capabilities of Macintosh computers with monochrome monitors. It was created using HyperCard 2.1 and for this study it was run on Macintosh LC computers in a thirty station lab.

During the data collection, all of the participants were required to wear headphones. The software and individual student records were stored at each workstation on the hard drive. At the end of each day of data collection, the student records were collected and aggregated for analyses.

Design. A 2x2 design was used (Figure 10) in this research. Variable one, degree of familiarity with the feedback provider, has two levels - familiar and unfamiliar. The second variable, type of feedback, has two levels - *Voice Only* and *Voice with Animated Character*. The treatments in the familiar condition used a person of authority (the school's media center teacher/librarian) that was known to the subjects as the vehicle for delivering feedback . In the treatments in the unfamiliar condition a fictitious character unknown to the subjects was used. In addition to the voice feedback, two groups received a visual of the speaker's face. Animation techniques were used to create the appearance that the speaker was actually talking as the feedback was delivered.

Procedures. Subjects participated in the research in intact classroom groups but individuals within groups were randomly assigned to one of four treatments. Classroom teachers did not play a role in the delivery of the instruction.

Over a period of three days, each subject completed two computer-based lessons on techniques used in advertising. The first lesson, which lasted approximately 20 minutes introduced students to four techniques and their defining attributes. Students were given an opportunity to practice identifying examples and non-examples of two of the techniques introduced. The second lesson, which lasted approximately 30 minutes, provided practice on the remaining two techniques and allowed for a brief review. Following the second lesson the students completed an on-line test consisting of 25 items (Cronbach's alpha, r=.87), five representing each of the four techniques studied and five non-examples. Finally, students responded on paper to seven questions focusing on effort, attitude and learning.

Data Analysis and Results. Analyses of variance were conducted to determine the effects of the treatment variables on the posttest scores. Neither the familiarity of the voice nor the presence of a feedback provider influenced overall performance (F=.54, p=.462 and F=.99, p=.321, see Table 1). No interactions of the treatment variables were found. Gender was found to be significant with girls outscoring boys by an average of 2 1/2 points. Means for the two groups are shown in Table 2.

Discussion. Analysis of the data related to the primary research questions, which addressed the issues of familiar versus unfamiliar and voice versus animated speaker, found no differences. This may indicate that the attribution of authority does not transfer to a computer representation of a teacher. Or, it may mean that a student's sense of accountability in a computer-based lesson is not influenced by the attribution of feedback to a specific source. Regardless of the source of the feedback as represented in the software, students may simple associate the feedback with the inanimate, non-judgmental delivery technology.

Some issues of secondary interest were identified and are deserving of discussion. Use of the "Say it again." option, which allowed students to have the verbal feedback repeated, appeared to be related to gender and treatment. Boys tended to use this option more in the familiar/voice with text treatment. Girls tended to use this option more in the unfamiliar/voice with face treatment.

Another, and perhaps related, secondary finding is that in spite of the pattern of option button use, girls spent more time working through treatments in which the feedback provider was known. Boys spent more time in treatments where the feedback provider was unknown. These findings might indicate that girls were willing to work harder at studying the information on the screen when they knew the feedback provider. When the provider was unknown, they may not have tried as hard. The feedback provider in the software studied was a female. This may also account for the differences in the ways in which the boys and girls used the material.

As a result of these findings a second study was designed and conducted to further explore the use of speech as feedback. It was determined that for the second study we would use a male speaker was unknown to the learners. Two new treatments, voice only and text that was read, were added to isolate any effect attributed to the voice variable.

Study Two

Participants. Subjects volunteering to participate in this study were 145 sixth grade students in a suburban Minneapolis middle school that served only fifth and sixth grades. Subset of volunteers with high (N=41) or low (N=49) reading abilities were identified. Only the scores from these individuals were used for this study although all 145 participated in the instruction. All of the participants had had regular contact with computer-based instruction prior to this study.

Instructional Materials. The instructional materials used in this lesson were the same as those describe in Study 1 except for the delivery of feedback which was specific to the treatment condition. The feedback in this study differed in that the audio was a male voice and the animated figure was of an unfamiliar male cartoon character.

The computers used in this study were in two labs of approximately 15 Macintoshes each. One lab was equipped with SE30 computers, the other was equipped with LC computers.

Design. A 2x3 research design was used. Variable one, type of feedback, has three levels - (1) spoken audio only, (2) printed and read (spoken), and (3) spoken by an animated character. The second variable, reading ability, has two levels - high and low.

Procedures. Subjects' classroom groups were divided in half and each half was required to report to one of two Macintosh computer labs where the studies were conducted. In each lab the subjects were randomly assigned to one of the treatments. Classroom teachers did not play a role in the delivery of the instruction.

Data Analysis and Results. Analyses of variance were conducted to determine the effects of the treatment variables on the posttest scores. Type of feedback was not found to have a significant effect on students' performance in this study (Table 3). However, ANOVA results do indicate that reading was significant (Table 4).

Discussion. Analysis of the data related to the primary research question (type of feedback) found no difference. However, there was a consistent tendency for students receiving only voice feedback to score higher on the posttest. This may indicate that supplementing the audio with text or graphics divides the learners' attention resulting in decreased comprehension.

The findings related to reading ability appear to reflect the participants' ability to read and learn from the text in the lesson. These findings indicate that the audio feedback component does not compensate for the text presentation of the content.

Conclusions and Recommendations

Following are a number of conclusions and recommendations based on the results of these studies and the observations of the researchers. While they may be tentative, they none-the-less provide food for thought and direction for future work.

1. Whose voice is used in the delivery of feedback in CBI seems to be of little importance. Perhaps of more importance is the gender of the speaker. In our first study, where a female agent was used, female students outperformed male students. In our second study, where the agent was a male, no performance difference based on gender was found. Whether this indicates that (1) girls work harder for a female agent, or (2) boys don't work as hard for a female agent, is worthy of further investigation.

2. The image associated with the speaker is of little importance. The students in our study did not appear to associate an agent on the screen with the person being represented. A possible topic for further investigation is whether younger learners would attribute more authority to the computer agent that represented a person they know.

3. It is reasonable to assume that if speech is going to effect a change in learning outcomes, then the amount and positioning of the speech within a lesson are of critical importance. In the studies we conducted speech was used only to deliver feedback. Much of the content was delivered through text. In our second study students' reading ability was found to have a significant effect on their learning. Therefore, it is reasonable to assume that an effective use of speech technology would be to help students overcome reading limitations that influence their processing of content.

4. During the research teachers and school staff repeatedly commented on the effect headphones had on student behavior. Once the headphones were on, student focused their attention on the computer lesson. Normal computer lab behavior appears to involve talking with others and looking around the room. Whether this auditory isolation produces better concentration, and thus improved performance, is uncertain.

5. Another observation made during the studies was that students in the animated character treatments were more demonstrative. They showed more facial expressions and talked back to the computers more than students in other treatments. The observers felt these students seemed to be more involved and to enjoy the lessons more. This may indicate a particular value to this method of integrating speech.

6. Regardless of what our research finds,we may not have a choice but to use speech and agents in instructional software. The use of these techniques is similar to the use of color. Increasingly our clients expect products to contain certain features. When they are not present, questions are raised and instructional products are devalued. Perhaps the most we can hope to do at this time is to moderate what we believe we can accomplish through the use of speech technology and proceed cautiously with its use.

7. In multimedia environments identification of primary symbol systems and the "most essential characteristics" of each is no small task. For spoken words, the list of characteristics includes, but is not limited to: gender of the speaker, tone, mode, pacing, cultural cues, and message. Furthermore, these characteristics may have varying degrees of importance to different learners.

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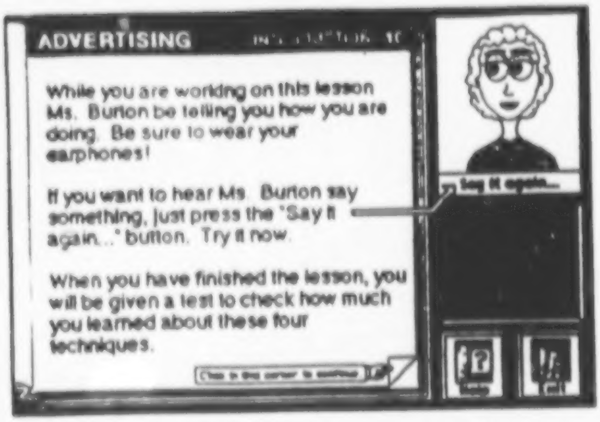
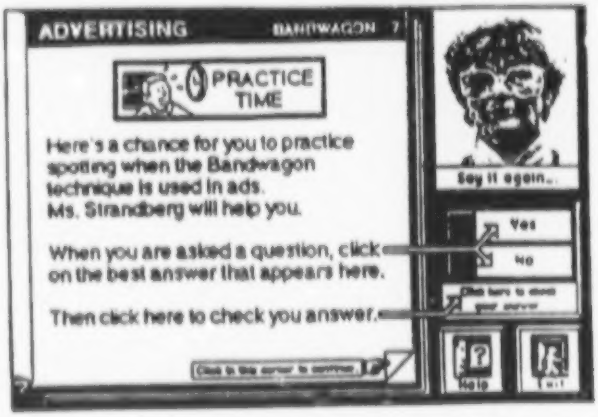

ADVERTISING
Say it again...
Help
Exit

While you are working on this lesson Ms. Burton be telling you how you are doing. Be sure to wear your earphones!

If you want to hear Ms. Burton say something, just press the "Say it again..." button. Try it now.

When you have finished the lesson, you will be given a test to check how much you learned about these four techniques.

Figure 1. Introduction from *Propaganda Techniques in Advertising* lesson describing audio controls.

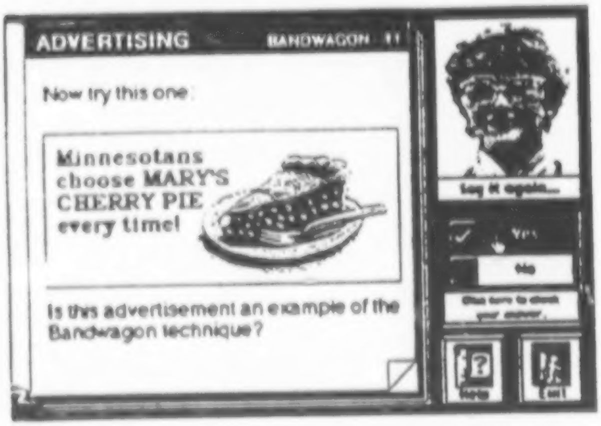

ADVERTISING
BANDWAGON 7
PRACTICE TIME
Say it again...
Yes
No
Help
Exit

Here's a chance for you to practice spotting when the Bandwagon technique is used in ads.
Ms. Strandberg will help you.

When you are asked a question, click on the best answer that appears here.

Then click here to check you answer.

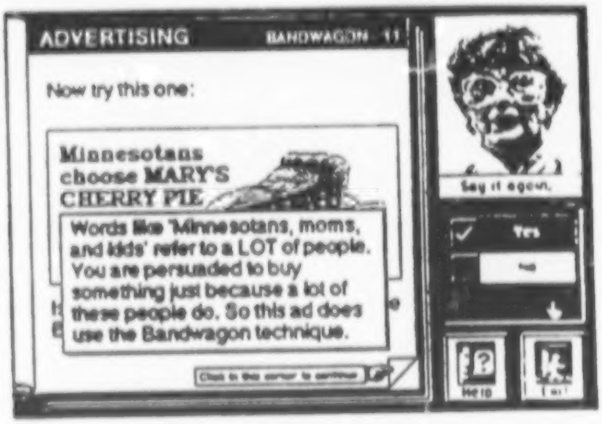
Figure 2. Beginning of practice section explaining response options.


ADVERTISING
BANDWAGON 11
Minnesotans choose MARY'S CHERRY PIE every time!
Say it again...
Yes
No
Help
Exit

Now try this one:

Is this advertisement an example of the Bandwagon technique?

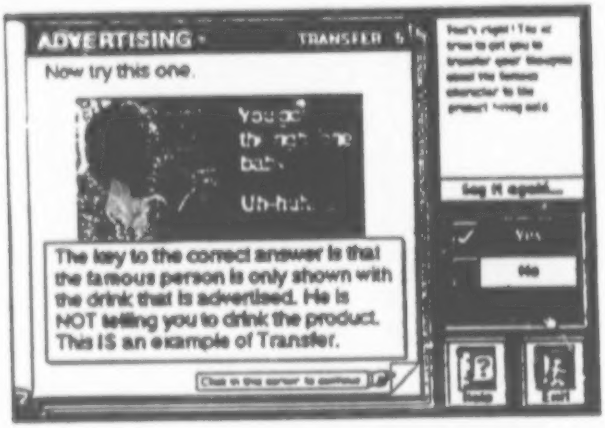
Figure 3. Typical practice item from the "familiar" voice and actor treatment just prior to response checking.


ADVERTISING
BANDWAGON 11
Minnesotans choose MARY'S CHERRY PIE
Say it again.
Yes
No
Help
Exit

Now try this one:

Words like 'Minnesotans, moms, and kids' refer to a LOT of people. You are persuaded to buy something just because a lot of these people do. So this ad does use the Bandwagon technique.

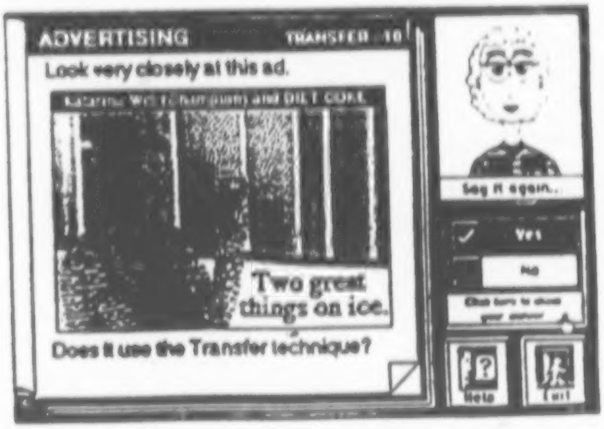
Figure 4. Additional feedback appearing in an overlaid window after audio feedback is delivered.


ADVERTISING
TRANSFER 5
Uh-huh.
Say it again...
Yes
No

Now try this one.

The key to the correct answer is that the famous person is only shown with the drink that is advertised. He is NOT telling you to drink the product. This IS an example of Transfer.

Figure 5. Feedback as displayed to the voice only treatments (both "familiar" and "unfamiliar" voice).


ADVERTISING
TRANSFER 10
DIET COKE
Two great things on ice.
Say it again..
Yes
No
Help
Exit

Look very closely at this ad.

Does it use the Transfer technique?

Figure 6. Practice item using the "unfamiliar" voice and actor.

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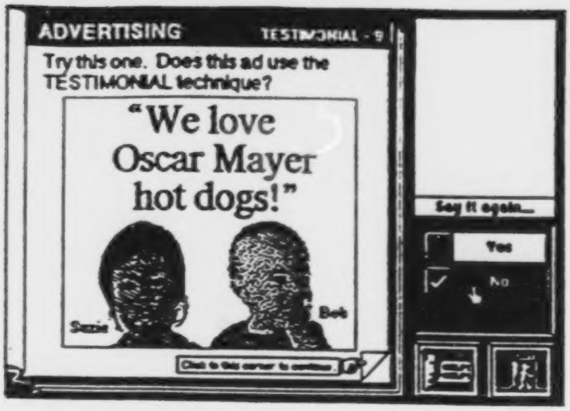
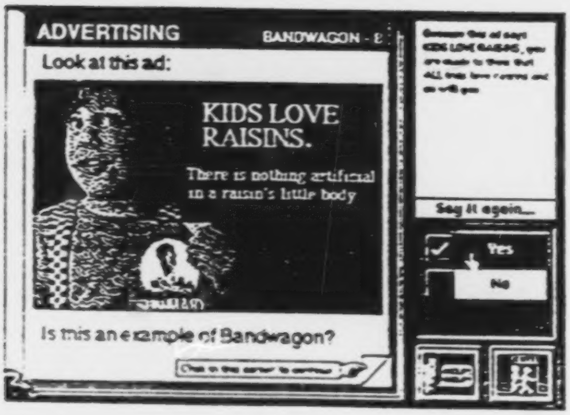


Try this one. Does this ad use the TESTIMONIAL technique?

ADVERTISING
TESTIMONIAL - 9
"We love Oscar Mayer hot dogs!"
Suzie
Bob
Say it again...
Yes
No

Figure 7: Spoken only.

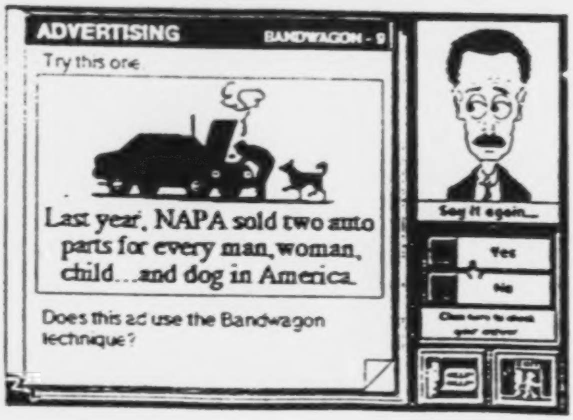


Look at this ad:

Is this an example of Bandwagon?

ADVERTISING
BANDWAGON - 8
KIDS LOVE RAISINS.
There is nothing artificial in a raisin's little body
Say it again...
Yes
No

Figure 8: Printed and read (spoken).



Try this one.

Does this ad use the Bandwagon technique?

ADVERTISING
BANDWAGON - 9
Last year, NAPA sold two auto parts for every man, woman, child...and dog in America.
Say it again...
Yes
No

Figure 9: Spoken by an animated character.

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Table 1

Analysis of Variance - Tests of Significance for Posttest Scores

Source of Variation	MS	F	Sig of F
within cells	25.88		
covariate	785.20	30.34	**.00**
familiar/unfamiliar	14.10	.54	.46
voice/image	25.71	.99	.32
gender	176.72	6.83	**.01**
familiar/unfamiliar by voice/image	.64	.02	.87
familiar/unfamiliar by gender	18.88	.73	.39
voice/image by gender	1.35	.05	.82
familiar/unfamiliar by voice/image by gender	3.34	.13	.72

Table 2

Summary of Posttest Scores by Gender

Gender	Mean Count Standard Deviation	
Boys	1	12.68 47 5.56
Girls	2	15.26 53 5.89
		14.0[illegible] 100 5.85

Figure 10

2x2 Research Design, Cell Size and Gender

	Familiar	**Unfamiliar**
Voice (with text)	**22** (14 girls, 8 boys)	**24** (17 girls, 7 boys)
Voice with Animated Character	**29** (11 girls, 18 boys)	**25** (11 girls, 14 boys)

Table 3. Means and Standard Deviations for Posttest Scores (Treatment by Ability)

Ability		Treatments 1	2	3	Total
High					
	Mean:	21.87	22.11	21.59	21.80
	SD:	3.83	2.57	4.00	3.59
	N:	15	9	17	41
Low					
	Mean:	16.07	13.95	15.13	14.94
	SD:	4.53	6.73	5.57	5.74
	N:	14	19	16	49
Combined					
	Mean:	19.07	16.57	18.45	18.07
	SD:	5.06	6.87	5.77	5.95
	N:	29	28	33	90

Table 4. Two-way ANOVA Results for Posttest Scores (Treatment by Reading Ability)

Source	df	SS	MS	F	p
Treatment	2	12.38	6.19	0.25	.778
Ability	1	985.60	985.60	40.14	.000
Interaction	2	19.47	9.73	0.40	.674
Error	84	2062.37	24.55		

Title:

Measuring Teacher Attitudes Toward Interactive Computer Technologies

Author:

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Measuring Teacher Attitudes Toward Interactive Computer Technologies

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Ours is an information-technology oriented society. Attitudes toward computer technology have therefore been of interest to researchers in the social sciences in recent years, based on the belief that attitudes toward technologies may influence their effective and innovative use. As early as 1976, Ahl administered a survey to American adults to determine their perceptions and understanding of computers. He found for example, that 85% of the Americans he surveyed felt that computers would improve education. Researchers interested in education have carried out similar studies with teachers and students. Lichtman found, for example, that in 1979 teachers were somewhat apprehensive about computers and their impact on schools.

Several researchers have sought to influence teacher attitudes toward computers using interventions, based on findings that experience with computers influences teacher attitudes (Koohang, 1987, 1989; Loyd & Gressard, 1986). For example, Madsen and Sebastiani (1987) and Berger and Carlson (1988) found that participation in computer courses influenced attitudes of inservice teachers. Similarly, Savenye, Davidson, and Orr (1992) found that participation in a semester-long computer applications course positively influenced preservice teachers' attitudes, however this study was limited in the attitudinal factors analysed, as it represented part of the evaluation of an ongoing course. There have been few comprehensive studies of the effects of such computer courses on the attitudes of preservice teachers. Such studies appear to be necessary. Although preservice teachers are entering computer literacy courses with increased prior experience in computers (Bitter & Davis, 1985), some say such experience can produce more negative attitudes than were previously held. For instance, in a recent study Mahmood and Medewitz (1989) found that for undergraduate business students, thus preservice practitioners, participation in a computer literacy course did not improve student attitudes, which in that case were already negative.

Elements of attitudes toward computers have been studied in a somewhat piecemeal fashion. For instance, some studies have investigated simple liking of computers, while others have focused on anxiety about using computers (Cambre & Cook, 1985, 1987). Computer anxiety itself has been variously defined by researchers as including elements of confidence, fear and comfort (Cambre & Cook, 1987), whereas others (Koohang, 1989) have analyzed elements of anxiety and confidence as separate factors. Koohang has also studied the factor of perceptions of usefulness, an extension of early work done on perceptions of value of computers to society. In his and other such comprehensive studies recently researchers have based their initial questionnaire development on thorough reviews of the literature, administered many attitudinal items, and have subsequently subjected their items to factor analysis to sort through the actual elements of computer attitudes (cf. Abdel-Gaid, Trueblood & Shrigley, 1986).

The present study was conducted with several purposes in mind: 1) to investigate in depth how attitudes among preservice teachers are influenced by participation in a computer literacy course, and 2) to test the utility of an extensive attitude questionnaire, based on several recent comprehensive studies.

Method

The subjects were 75 college preservice teachers, 56 females and 19 males, enrolled in two five-week summer sessions of a required course on computer applications in education at a major university in the southwest.

The computer literacy course was systematically developed to teach the use and understanding of computer technologies in an educational setting. The course is taught by many instructors, in a multi-section format, but content, activities, projects and exams are the same for all sections. All students thus received the same instruction.

As a normal procedure in the computer literacy course, students every semester complete pre-and-post course surveys to help instructors maintain and improve the quality of the course. During one summer, an additional questionnaire, the Computer Literacy Attitude Survey (described below), was specifically developed to study in depth the effects of the course on attitudes. This Attitude Survey was administered at the same time as the regular course surveys.

Data Sources

Seventy-three students completed the Computer Literacy Attitude Survey after the first class. Sixty-five students completed the Survey again on the next-to-last class day. The Survey consisted of fifty Likert-scale type items derived from several sources (Abdel, et al., 1986; Bannon, Marshall, & Fluegal, 1985; Ellsworth & Bowman; 1982; Smith, 1987; and Violato, Marini & Hunter, 1989). The survey contained items related to the factors of liking of computers, valuing computers for society and for education; anxiety about using computers; confidence with regard to learning about computers; and perceptions of gender appropriateness of computers. Students were asked to rate the items from strongly agree to strongly disagree.

Students also completed a brief questionnaire regarding their demographic characteristics and previous computer experience.

Data Analysis

First, several types of descriptive data were collected and analyzed. Students were asked several questions about their background, and frequencies were calculated for these questions. Two questions each on the pre- and post-course survey asked students to rate their skill in typing and computer programming, and mean scores on these questions were calculated.

For the fifty Likert-scale questions regarding the preservice teachers' attitudes toward computers, which represented the primary focus of the study, pre- and post-course mean scores were calculated . To calculate statistics, strongly agree was given a value of 1, agree was given a value of 2, up to strongly disagree with a value of 5. Thus on positively-worded items, a low score represented a positive attitude, with the reverse being true on negatively-worded items.

To determine the effects of participating in the computer applications course, multiple t-tests were used to compare attitudes at the beginning and at the end of the course. Since use of multiple t-tests introduces the possibility of finding spurious significant differences, a highly-stringent probability value was used to determine whether differences were meaningfully significant. Items on which pre- and post-course differences were significant at the p<.0001 level were considered to represent the most important attitude changes. Secondarily, differences at the p<.001 level were also explored.

Results

A summary of the characteristics of the subjects is presented in Table 1. Most of the students were education majors, seeking teaching certification. Most had not completed their student teaching and were not currently teaching. Students appeared to have enrolled in the computer course at varied points in their college career; about half had completed only a few education courses, while about half had completed more than six courses. Most students had had little experience with microcomputers, with 40 of 73 who answered having less than six months of experience, and 33 having more than 6 months' experience.

Table 2 presents the results of the students' pre- and post-course self-ratings of their skill in typing and computer programming. In both areas, students' perceived that their skill had improved, however the improvement was greater in computer programming. Students appear to have entered the course with good typing skill, whereas their initial programming skill was low, and could be improved considerably through their experience in the course.

Table 3 presents results on all 50 Attitude Survey items, with responses to the items worded positively appearing first (Table 3a). The lower the mean score the more positive the attitude on these items, with scores ranging from 1 (most positive) to 5 (least positive). The second half of Table 3 (Table 3b) presents responses to items worded negatively. On these items the higher the mean score, the more positive the attitude (1 - least positive to 5 - most positive). Questions were assigned to the following categories, derived from the literature: liking of computers, anxiety, value of computers for society and education, confidence about learning about and using computers, and perceptions of gender-appropriateness of computer use. Although Table 3 presents all results, major results will be discussed here.

As shown in Table 3, attitudes toward computers, as indicated by responses on the 50-item Survey, were generally more positive after the students had completed the computer literacy course. Attitudes on all but eight items became more positive, and on those few items the differences were not statistically significant.

On twelve items there were highly significant pre-post differences, at the p<.0001 level, so positive attitude changes represented by these items were considered to be of major importance. It is in the area of anxiety about computers, and the related factors, confidence in learning about and confidence in using computers, that the greatest attitude changes appear. In fact, of the twelve most significant attitude changes, eight were related to anxiety and confidence. These items, noted in Table 3, were items #103, 109, 111, 117, 118, 123, 127, and 129. For example, responses to item #109, "I get a sinking feeling when I think of trying to use a computer," showed the greatest increase of those to any item (3.45 pre, 4.25 post. Note that on negatively-worded items a higher score is more positive.). Similar results occurred in response to the other anxiety/confidence items: item #103, "I feel confident with my ability to learn about computers," (2.42 pre, 1.72 post), #111, "Computers make me feel stupid," (2.95 pre, 3.69 post), #117, "I'm not the type to do well with computers," (3.51 pre, 4.00 post), #118, "I feel comfortable using computers," (2.75 pre, 2.11 post), #123, "Computers make me feel uncomfortable," (3.22 pre, 4.05 post), #127, "Computers make me feel uneasy and confused," (3.30 pre, 3.95 post), and #129, "I think using a computer would be difficult for me," (3.51 pre, 3.98 post).

Significant differences at the p<.0001 level also occurred on three items related to liking computers (items #102, #107, and #128). For example, the mean scores on one of the liking items, #102, "I like using computers," were 2.27 pre- and 1.75 post-course. Finally, differences at this highly significant level were found on one item, #141, related to valuing computers. The preservice teachers disagreed more strongly at the end of the course with the statement, "Microcomputers will increase the amount of stress and anxiety students experience in schools," (3.47 pre, 3.64 post).

Also, as noted on Table 3, on five additional items pre-post differences were significant at the somewhat lower level of p<.001. Again on these items the preservice teachers showed more positive attitudes at the end of the course with relation to anxiety towards (item #104), liking (item #121), and valuing computers (items #140, #142, #147).

Thus the general pattern of significant differences on the pre-course versus post-course administration of the Attitude Survey indicated an improvement in attitudes toward computers. Initially the non-significant decline in scores on the eight items mentioned earlier was still of some concern, because five of the items were related to perceptions of computers as a male domain, that is, the scores seemed to indicate increased sex-stereotyping. For example, scores on item #106, "Using a computer is more important for males than females," were 4.71 (pre) and 4.45 (post), and scores on item #130, "Working with computers is more for males than females," decreased from 4.65 (pre) to 4.52 (post). Responses on a few of the other items were already very positive at the beginning of the course and became only slightly less positive. For instance on item #101, "Knowing how to use computers is a worthwhile and necessary skill," mean scores were 1.26 (pre) and 1.42 (post). Similarly, in response to item #112, "If a problem is left unsolved in a computer class, I would continue to think about it afterwards," students' mean scores were 2.22 (pre) and 2.42 (post). As mentioned earlier, the decline in scores on these eight items, although noted on Table 3, does not appear to be important in that none of the differences on these items was statistically significant.

Discussion

This study was conducted to investigate in-depth the effects of participation in a computer literacy course on the attitudes of preservice teachers towards computers. While many researchers have studied computer attitudes, few have investigated the effects on attitudes of long-term participation in a computer course. Of particular interest to educators are the effects of such a course on the attitudes of teachers. This study extended previous work conducted with preservice teachers.

In this study, participation in the course appears to have improved students' attitudes. Students' responses indicated that they liked computers more at the end of the course, had less anxiety about using computers, had more confidence in their ability to learn about and use computers, and generally valued computers more for education and for society in general.

The design of the computer literacy course itself was studied in an effort to begin to determine why attitudes may have improved so significantly on so many factors, particularly anxiety and confidence about using computers. Of importance was the fact that the course was systematically designed, based on sound principles of instructional development (cf. Dick & Carey, 1990; Gagne, Briggs, & Wager, 1988; Sullivan & Higgins, 1983). At the beginning of each segment of the course the preservice teachers were provided with a set of objectives which clearly described the skills and knowledge they would be mastering. Instruction, frequent hands-on practice, and objectives-based feedback were provided. Tests and projects measured skills and knowledge the students knew they were responsible for. (For a more complete description of the course, see Savenye, Davidson, and Smith, 1991). These preservice teachers, in fact, throughout the course frequently mentioned to instructors and the professors coordinating the course that they felt the course was clear and fair and that they were learning useful skills. They often said the significant amounts of hands-on practice made them feel more comfortable using computers now and later when they would be teachers.

Thus it appears that an intense, systematically-designed course emphasizing hands-on computer skills teachers would use later in their classrooms may have made the difference in making attitudes toward computers more positive. While it is difficult to manipulate these factors and experiences in existing college courses which often are required to teach certain skills by state mandate, future studies might be conducted to begin to parcel out which elements in such a course seem to be most effective. This could prove especially useful for practitioners who are responsible for designing short courses to train inservice teachers, and other computer trainers who need to know how to have the most impact in the shortest time.

That scores declined somewhat on eight of the fifty items does not appear to be of serious concern. First, the differences were not statistically significant. In addition, the decrease on at least one item was likely to have been due to the fact that the students had just completed an intensive summer course on computers. Athough their attitudes were still positive, students were not as likely at the end of their perhaps grueling experience to say, for example, that they would continue to think about an unsolved computer problem after class. The declines on a few of the other items seem to follow a pattern which appeared in the Savenye, et al., 1992 study. After learning about appropriate and inappropriate classroom uses of computers, students seem to have a less glowing overall opinion about the value of computers. They were somewhat less likely to indicate that knowing how to use computers is a worthwhile and necessary skill, and somewhat more likely to indicate that our country would be better off if there were no computers. Again, the latter response may simply be an indication of weariness of the topic of computers at the end of an intense course of instruction.

While the tendency of some of these primarily female students to regard computers as more of a male domain after their computer course than before was not significant, it may yet be worth investigating. While most of the students in the course were females, the two course instructors were foreign-born males. As Bandura (1986) has stated, role models can have a significant influence on behaviors. In her 1990 study on the effects of role models on student attitudes toward gender-appropriateness of careers, Savenye indicated that gender of the role model can influence perceptions of the gender-appropriateness of activities. It appears that a worthy research question would be the effects of the gender of the course instructor, and possible interactions with gender of student on student perceptions of how appropriate computer activities are for men and women.

Another interesting investigation might be to conduct a factor analysis, possibly by pooling many data sets, to determine how the fifty items load on factors derived from the theoretical and empirical literature mentioned in the introduction.

Conclusion

Many national studies have called for increased use of technology in school (cf. U.S. Congress, Office of Technology Assessment, 1989). Well-trained teachers are the key to effective use of technology. Snelbecker (1981) has suggested that teachers are the critical factor in successful implementation of technology in the schools. This study was based on the assumption that teacher success in learning about technology is partially dependent upon positive attitudes toward technology. That such an assumption is justified is supported by the work of such researchers as Stevens (1982). While this study indicates that a systematically-designed computer literacy course improves attitudes preservice teachers, future researchers should investigate the most powerful attitudinal factors related to computers, the instruments used to collect computer attitude data, the effects of gender of student and gender of instructor, and methods for directly influencing attitudes of teachers toward computers and other technologies.

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Table 1
Characteristics of the Preservice Teachers in the Computer Attitude Study

	Characteristics					
1.	Major?	Education	Other			
		45	23			
		(66.2%)	(33.8)			
2.	Seeking certification?	Yes	No			
		58	15			
		(79.5%)	(20.5%)			
3.	Completed student teaching?	Yes	No			
		18	54			
		(25.0%)	(75.0%)			
4.	Currently teaching?	Yes	No			
		13	60			
		(17.8%)	(82.2%)			
5.	Number of previous courses in education?	0	1-2	3-4	5-6	>6 courses
		11	23	11	7	21
		(15.1%)	(31.5%)	(15.1%)	(9.6%)	(28.8%)
6.	Previous experience operating microcomputers?	0	few days to 1 mo.	1-6 mos.	7 mos	>1 yr.
		15	16	9	8	25
		(20.5%)	(21.9%)	(12.3%)	(11.0%)	(34.2%)
8.	Own or have easy access to a microcomputer?	Yes	No	Missing		
		29	43	1		
		(39.7%)	(58.9%)	(1.4%)		
9.	Taken any formal or informal courses in use of computers?	Yes	No			
		31	42			
		(42.5%)	(57.5%)			

Table 2
Pre- and Post-Course Mean Self-Ratings of Skills

Competency		PRE Mean	POST Mean
A.	How would you rate your typing skill?	2.58	2.91
B.	How would you rate your computer programming skill (in any language)?	1.34	2.82

Note. Scores range from 1 (nonexistent) through 2 (poor), and 3 (good) to 4 (excellent).

Table 3a

Pre- and Post-Course Mean Scores on Computer Attitudes

Items Worded Positively Mean		PRE Mean	POST	
Liking of Computers				
102.	I like using computers.	2.27	1.75	**
107.	I like using computers in my school work.	2.38	1.80	**
108.	I wish I could use computers more frequently at the university.	2.49	2.20	
110.	Once I start to work with the computer, I would find it hard to stop.	2.98	2.58	
112.	If a problem is left unsolved in a computer class, I would continue to think about it afterwards.	2.22	2.42	--
114.	A job using computers would be very interesting.	2.74	2.55	
116.	I look forward to using the computers at the university.	2.41	2.17	
121.	When there is a problem with a computer program I can't immediately solve, I would stick with it until I have the answer.	2.62	2.18	*
128.	I think working with computers would be both enjoyable and stimulating.	2.33	2.23	**
149.	Someday I will have a computer in my home.	1.69	1.55	
Anxiety (Or Lack of It) About Computers				
Value of Computers for Society				
101.	Knowing how to use computers is a worthwhile and necessary skill.	1.26	1.42	--
132.	I will probably need to know how to use a computer when I leave school.	1.88	1.68	
Value of Computers for Education				
105.	I will use my knowledge of computers in many ways as a teacher.	2.27	2.02	
122.	Learning about computers is a worthwhile and necessary subject for all prospective teachers.	1.71	1.71	

Table 3a, cont.

Pre- and Post-Course Mean Scores on Computer Attitudes

Items Worded Positively , cont.		PRE Mean	POST Mean	
Value of Computers for Education, cont.				
124.	It is important to know how to use computers in order to get a teaching position.	2.77	2.66	
134.	Supplying every student with a microcomputer is a worthy educational objective.	2.38	2.23	
135.	Teachers should demand that they be taught how to use microcomputers in their classrooms.	2.54	2.24	
136.	Microcomputers will require students to become active learners.	2.39	2.17	
139.	If we do not use microcomputers in school instruction, our students will grow up illiterate and deprived of a basic skill.	3.08	3.00	
140.	If my school district had the money, I would insist that they buy microcomputers in most every school subject.	2.81	2.38	*
145.	Computers can improve learning of higher-order skills.	2.21	2.13	
150.	Computers will improve education.	1.80	1.75	
Confidence About Learning About Computers				
103.	I feel confident about my ability to learn about computers.	2.42	1.72	**
125.	I know that if I work hard to learn about computers, I can do well.	1.64	1.60	
Confidence About Using Computers				
118.	I feel comfortable using computers.	2.75	2.11	**
131.	I am able to do as well working with computers as most of my fellow students.	2.33	1.97	
Perceptions About Gender-Appropriateness of Computer Use				
126.	Females can do as well as males in learning about computers.	1.36	1.38	--

Note. Mean scores range from most positive (1 = Strongly Agree) to least positive (5= Strongly Disagree). N may vary due to students skipping some items.
-- indicates an item for which responses were more negative after the course.
** pre/post differences significant at the p<.0001 level
* pre/post differences significant at the p<.001 level

Table 3b

Pre- and Post-Course Mean Scores on Computer Attitudes

Items Worded Negatively Mean		PRE Mean	POST	
Liking of Computers				
119.	Working with computers is boring.	3.68	4.03	
Anxiety (Or Lack of It) About Computers				
104.	Working with a computer would make me nervous.	3.48	3.98	*
109.	I get a sinking feeling when I think of trying to use a computer.	3.45	4.25	**
111.	Computers make me feel stupid.	2.95	3.69	**
117.	I'm not the type to do well with computers.	3.51	4.00	**
123.	Computers make me feel uncomfortable.	3.22	4.05	**
127.	Computers make me feel uneasy and confused.	3.30	3.95	**
129.	I think using a computer would be difficult for me.	3.51	3.98	**
Value of Computers for Society				
115.	I don't expect to use computers when I get out of school.	4.03	4.23	
133.	Computers are gaining too much control over people's lives.	3.35	3.66	

Table 3b, cont.

Pre- and Post-Course Mean Scores on Computer Attitudes

Items Worded Negatively, cont.		PRE Mean	POST Mean	
Value of Computers for Education, cont.				
137.	Microcomputer instruction will deny students the opportunity to reason with others.	3.46	3.73	
138.	Using microcomputers as a teaching tool puts too much additional work on already overburdened teachers.	3.60	3.73	
141.	Microcomputers will increase the amount of stress and anxiety students experience in schools.	3.47	3.64	**
142.	Microcomputers will decrease the amount of teacher-pupil interaction in schools.	3.15	3.58	*
143.	Microcomputers will isolate students from one another.	3.33	3.59	
144.	I object to all the attention being given to computer technology because it detracts from the real problems now faced by teachers.	3.50	3.69	
146.	Computers will displace teachers.	4.11	4.33	
147.	Computers will dehumanize teaching.	3.70	4.03	*
148.	Our country would be better off if there were no computers.	4.48	4.39	--
Confidence About Learning About Computers				
Confidence About Using Computers				
Perceptions About Gender-Appropriateness of Computer Use				
106.	Using a computer is more important for males than females.	4.71	4.45	--
113.	More men than women have the ability to become computer scientists.	4.62	4.58	--
120.	Using computers is more enjoyable for males than females.	4.60	4.56	--
130.	Working with computers is more for males than females.	4.65	4.52	--

Note. Mean scores range from most negative (1 = Strongly Agree) to least negative (5= Strongly Disagree). N may vary due to students skipping some items.
-- indicates an item for which responses were more negative after the course.
** pre/post differences significant at the p<.0001 level
* pre/post differences significant at the p<.001 level

Title:

Classifying Interaction for Emerging Technologies and Implications for Learner Control

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Classifying Interaction for Emerging Technologies and Implications for Learner Control

Abstract

This paper describes a classification scheme for multimedia interaction based on the degree of control and type of cognitive engagement experienced by learners in prescriptive, democratic and cybernetic independent learning environments. Reactive, proactive and mutual levels of interaction, and their associated funtions and transactions are discussed. The paper also explores principles for designing interactive multimedia instruction which emerge from this classification and current research on learner control.

Genesis of a Taxonomy of Interaction

The need for a taxonomy of interaction for emerging technologies grew out of the interactive videodisc literature, which used the term *levels* to describe hardware-dependent ways learners could operate equipment and software. Commonly accepted labels for levels of interactivity were, and remain, Level I, II, III, and sometimes IV, depending on your reference (Iuppa, 1984; Katz and Keet, 1990; Katz, 1992; Schwartz, 1987; Schwier, 1987). Level I videodiscs were controlled by the learner with a remote control unit to access frames or segments on the discs. Level II interactivity featured control programs recorded on videodiscs which could only be accessed by compatible players. Level III interactivity occurred when the control programs for a videodisc were provided by an external computer connected to a player. Level IV usually introduced sophisticated interfaces, such as touch screens, into the system.

These levels say little about the quality of interaction engaged by the learner (see Figure 1). What is the relative quality of cognitive engagement experienced by a learner who presses buttons on an RCU (Level I) versus a learner who touches the screen (Level IV)? Many would argue that there is little difference, if any, in the level of thought required in the actions, yet they are categorized as dramatically different levels of interaction. However convenient this designation may have been or continues to be for interactive video, for environments created by emerging technologies it is more productive to characterize interaction according to the sophistication and quality of interaction available to a learner in a particular program.

Figure 1. Interactive features of level I, II and III videodiscs.

	Program Control	Program Structure	System Costs	Flexibility
Level I	remote control unit	linear or user-defined	least expensive option	free access to segments of videodisc
Level II	embedded program	strictly defined by program on disc—may be overridden	higher videodisc production and hardware costs	response to programmed options typically limited to single keypress
Level III	external computer program	defined by program on external computer	added cost of computer in the system	dependent upon program or programming skills of user

A Taxonomy of Interaction for Emerging Technologies

Multimedia-based independent learning happens in several contexts, depending upon the nature of the learning task, the abilities and preferences of the learner, and the external requirements of the learning context. Learning may occur in prescriptive, democratic or cybernetic environments, each of which may be appropriate or inappropriate to accomplish defined learning tasks (Romiszowski, 1986).

Instructional designers acknowledge the role played by prescriptive types of instruction; indeed, prescriptive instruction has dominated the attention of instructional design for decades. Some types of learning, say performing double-ledger accounting, may be appropriately addressed in a confined, externally defined and structured, highly proceduralized fashion. An instructional designer can develop effective, reliable instructional materials to address this problem.

But emerging technologies require us to look at independent learning systems in a new way—as environments which promote the learner's role in regulating learning. Emerging technologies focus on an ability to manage, deliver and control a wide range of educational activities (Hannafin, 1992). Instructional designers must look beyond the attributes and differences of individual media components, and instead extend attributes across developing technologies. To fully exploit the capabilities of more powerful instructional technologies, designers must also reexamine the assumptions, models and strategies we employ in instructional design (Cognition and Technology Group at Vanderbilt, 1992; Jonassen, 1991; Osman and Hannafin, 1992; Rieber, 1992; Schott, 1992; Spector, Muraida and Marlino, 1992; Tennyson, Elmore and Snyder, 1992).

Emerging technologies offer an expanding range of interactive possibilities which are remarkably consistent, regardless of the platform used to deliver the instruction. Because a computer acts as the heart of a multimedia learning system, and because most multimedia computer systems have similar devices for communicating (e.g., keyboard, mouse, touch screen, voice synthesis), the quality of interaction is more the product of the way instruction is designed, and less the result of the system on which it is delivered. In order to describe a taxonomy of interaction for multimedia instruction, this paper describes three learning environments within which interactive multimedia function, suggests three levels of interaction commensurate with these environments, examines functions played by interaction within these levels and enumerates several types of overt transactions available at each functional level of interaction (Figure 2).

Figure 2. A taxonomy of interaction for multimedia instruction.

Multimedia Learning Environments	Levels of Interaction	Functions of Interaction	Transactions Performed to Interact
Prescriptive	Reactive	Confirmation	Space Bar/Return
Democratic	Proactive	Pacing	Touch Target
Cybernetic	Mutual	Navigation	Move Target
		Inquiry	Barcode
		Elaboration	Keyboard
			Voice Input
			Virtual Reality

884

Multimedia Learning Environments

Instruction is shaped by the instructional designer's knowledge of the learning task, learner and context. It is also influenced by assumptions about the learner and learning—assumptions which reveal the orientation of the learning materials. These factors, among others, conspire to define a multimedia environment. Romizowski (1986) used the terms prescriptive, democratic and cybernetic to describe a schemata of systems for individualizing instruction; systems which may also be considered *environments* in multimedia instruction.

Prescriptive instruction specifies what the learner is to learn. Instruction is based on specific objectives and the instructional system is used as a primary delivery medium. In many, if not most, cases the instructional content and boundaries of learning are decided by the instructional designer, and the learner's role is to receive and master the given content. A popular breakdown of prescriptive instructional designs for computer-based instruction includes drill and practice, tutorials, games and simulations (e.g. Alessi and Trollip, 1985; Hannafin and Peck, 1988; Heinich, Molenda, and Russell, 1989; Romiszowski, 1986). Recently, instructional design theory has offered models for dealing with higher-order learning and more complex cognitive skills with prescriptive design models based on cognitive theory (e.g., Merrienboer, Jeisma, & Paas, 1992;Tennyson, Elmore, & Snyder, 1992). Although such models do not offer a complete theory of instructional design based on cognitive theory, they offer potentially powerful solutions to specific design challenges (Schott, 1992).

Democratic environments turn over control of instruction to the user. Unlike prescriptive environments, democratic environments do not impose highly structured learning strategies on the learner. Rather, democratic environments emphasize the learner's role in defining what is learned, how it is learned, and the sequence in which it is learned. The most apparent difference between democratic and prescriptive environments is the level of learner control, and they do not always operate in isolation from one another. Democratic environments may be used to support prescriptive instruction, acting as a supplementary resource to the primary instruction. For example, a learner following a self-instructional program on a comparison of British and American forms of government (prescriptive) might choose to explore a learning resource on the Canadian House of Commons to elaborate information for an assignment (democratic). For other democratically oriented learning, resources stand alone, without reference to prescribed instruction, and the learner makes virtually every decision about how the materials are used. These types of learning resources emphasize navigation, motivation and access, and they downplay objectives and evaluation.

Cybernetic environments emphasize a complete, multi-faceted system in which the learner can operate naturally, albeit synthetically. Intelligent interactive multimedia, based on expert systems, heuristic designs, and virtual reality can provide rich, dynamic and realistic artificial environments for learning. In cybernetic environments, the learner maintains primary control of the learning, but the system continually adapts to learner activity, and may even adapt in novel ways based on heuristic interpretations of learner actions. The learning environment may either adapt actively, or passively by advising the learner about the patterns and consequences of actions taken. The instructional environment, unlike instruction provided at proactive and reactive levels, actually expands beyond the initial design decisions made during its development.

Jonassen (1991) might use the term *objective* (encompassing both behavioural and cognitive orientations) to describe prescriptive environments as they are based on assumptions of a single, externally defined reality, wherein the goal of instruction is to bring the learner into line with these externally defined goals. Democratic and Cybernetic environments might emphasize a more *constructivist* orientation—one in which multiple realities are recognized as legitimate, and therefore, learners may be empowered to express an array of appropriate directions, processes and outcomes for learning. Fundamental to the movement toward more constructivist orientations in instructional design, is a respect for the learner's ability to understand and select from a number of personally satisfying strategies for learning. For example, Osman and Hannafin (1992) challenge designers to go beyond content acquisition in designs, and cultivate metacognitive capabilities and strategies of learners. This, in turn, requires that instructional designers include procedures and tools learners can use for the specific content to be learned and generalize to other settings, rather than focus solely on specific content and skills to be learned.

Levels of Interaction

The different multimedia environments will emphasize different levels of interaction. Such interaction can be characterized as reactive, proactive or mutual depending upon the level of engagement experienced by the learner.

In a reactive interaction a learner responds to stimuli presented to the learner by the program, for example by making a selection from a menu (Lucas, 1992; Thompson and Jorgensen, 1989). Such approaches are typified by tutorial designs wherein the learner and computer are engaged in a preordained discussion which is initiated by the program, not the learner.

By contrast, proactive interaction requires the learner to initiate action or dialog with the program. Proactive interaction promotes generative activity; that is, the learner goes beyond selecting or responding to existing structures and begins to generate unique approaches and constructions other than those provided in instructional materials. An example of this is when a learner uses key word searching of a hypermedia database, organizes resultant information to address a self-generated question.

The highest level of interaction, mutual interaction, is characterized by artificial intelligence or virtual reality designs. In such programs, the learner and system are mutually adaptive. Sometimes, this is referred to as recursive interaction. Recursion is based on the mathematical notion of indefinite repetition, and in multimedia, it suggests a conversation which can continue indefinitely. This is a useful distinction, but it falls short of the potential capabilities of multimedia systems in the future. Because multimedia systems may ultimately be capable of cybernetic conversation–actually learning from and adapting to conversation with a learner–the term *mutual* interaction is used here. At a less sophisticated level, mutual interaction can be used to describe the appearance or trappings of meaningful conversation. Mutual interactivity is still in its infancy, but the area is attracting a great deal of research and development interest.

The three categories of interaction do not exist as "pure" categories in most instructional software—interactive multimedia programs often incorporate a combination of reactive and proactive approaches (although very few are sophisticated enough to incorporate mutual approaches). But the levels are hierarchical, in that one subsumes the other. In other words, mutual interactions contain proactive elements, and proactive interactions contain reactive elements. For example, when learners generate new questions and approaches (proactive) they can, in turn, be used by the system to formulate new conversation (mutual). Similarly, when learners generate their own strategies (proactive) they are responding to existing stimuli at a sophisticated level (reactive).

Functions of Interaction

Hannafin (1989) identified five functions interaction can serve in independent learning materials: confirmation, pacing, inquiry, navigation and elaboration. Confirmation verifies whether intended learning has occurred (e.g., learners responding to questions during instruction can measure performance). Pacing gives control of the timing of instruction to the learner (e.g., the learners selecting an abbreviated or elaborated version of instructional content). Navigation determines the amount of freedom and ease of access learners have to instructional components (e.g. learners choosing segments from a menu). Inquiry allows learners to ask questions or construct individual pathways through instruction (e.g. learners searching supplementary material). Elaboration allows learners to move from known to unknown information or expand what is already known.

Each function is expressed differently during instruction, depending upon the level of interaction. For example, reactive navigation is typified by menus or prescribed branching options presented to learners. Proactive navigation, by contrast, would permit the learner to initiate searches or participate in open-architecture movement throughout material. Mutual navigation might happen when a program anticipates navigation routes of the learner based on previous movement, and advises the learner about the nature of choices made. In mutual navigation, the learner could could follow or ignore the advice, and also advise the system about about the nature of navigation opportunities desired. Figure 3 gives one example of interaction obtained at each functional level of the taxonomy.

Transactions During Interaction

Transactions are what learners do during interaction; they are the mechanics of how interaction is accomplished. For example, learners type, click a mouse, touch a screen or scan a virtual environment. Learners can also engage in many productive types of covert transactions, mentally engaging themselves in the construction of metaphors, questioning the validity of content, constructing acronyms to remember material and the like. This discussion will focus on overt transactions, but the reader should realize that covert transactions can be employed whenever overt transactions are unavailable to the learner. Also, the use of one does not preclude the use of another.

The level of interaction can be influenced by the type of interaction permitted by hardware configurations and instructional designs, and therefore the transactions. Several transactions cannot be easily adapted to higher levels of interaction. For example, the range of possible interactions is confined if a spacebar is the only means of interacting with a program. Devices such as the mouse and instructional design strategies such as touch screen menus do not permit the learner to construct inquiries, thereby eliminating the possibility of adopting a proactive or mutual orientation. For example, a learner can use a touch screen or use a single keyboard entry to make menu selections or answer questions (reactive interaction). Touch screens and single keyboard entries are too restrictive, however, to be used for generative interactions such as on-line note taking (proactive interaction).

Conversely, transactional methods serving proactive or mutual interactions can also be used in reactive interactions. For example, a keyboard synthesizer can be used by a learner to compose a new song (proactive interaction), while the same keyboard synthesizer can be used to have learners mimic a score played by a program (reactive interaction). In this way, transactions conform to the hierarchy of this taxonomy. Transactional events available for higher levels of interaction can be adapted to lower levels of interaction, but the relationship is not reciprocal.

Figure 4 lists several transactional events which can be employed at reactive, proactive and mutual levels of interaction. The list of transactions is not exhaustive, but it illustrates some interactive strategies employed in interactive multimedia programs. The figures illustrate the notion that as interaction reaches for higher levels of engagement with learners, generative transactions are required.

Figure 3.Example of an interactive event each functional level of interaction.

	Confirmation	**Pacing**	**Navigation**	**Inquiry**	**Elaboration**
Reactive	Learner matches answer given by system	Learner turns page when prompted	Learner selects choice from a menu	Learner uses "help" menu	Learner reviews a concept map
Proactive	Learner requests test when offered	Learner requests an abbreviated version of instruction	Learner defines unique path through instruction	Learner searches text using keywords	Learner generates a concept map of the instruction
Mutual	System adapts to progress of learner and learner may challenge assessment	System adapts speed of presentation to the speed of the learner	System advises learner about patterns of choices being made during instruction	System suggests productive questions for the learner to ask, given previous choices	System constructs an example based on learner input, and revises it as learner adds information

Figure 4. Some examples of transactions available to serve different functions and levels of interaction.[2]

	Reactive	**Proactive****	**Mutual*****
Confirmation	Touch Target Drag Target Barcode Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality
Pacing	Space Bar/Return Touch Target Barcode Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality
Navigation	Touch Target Barcode Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality
Inquiry	Touch Target Barcode Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality
Elaboration	*	Keyboard Voice Virtual Reality	Keyboard Voice Virtual Reality

* **Note:** At a reactive level of interaction, elaboration would be restricted to covert responses to stimuli (e.g. "think about this image").

****Note:** Because the learner must generate original input to be truly proactive, only overt transactions which permit generation of complex information were identified.

*****Note:** Mutuality implies sharing complex information between user and system, therefore requiring complex dialogue.

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[2] Figures 3 and 4 are adapted from material originally published in Schwier and Misanchuk (1993).

Implications of the Taxonomy for Instructional Design

The taxonomy carries implications for instructional design, primarily concerning questions of learner control. An instructional developer constantly weighs the need to be prescriptive versus the need for learners to explore. How does learner control converge with the proposed taxonomy? *Learner control* may refer to a number of things. Learners may be granted or may require control over:

- Content of instruction.
- Context for learning.
- Presentation method of the content.
- Provision of optional content.
- Sequence of material to be learned.
- Amount of practice.
- Level of difficulty.
- Level of advisement.

The taxonomy is meant to be descriptive, not prescriptive, yet each of these points of control represents a decision point for an instructional designer. As levels of interaction are ascended by the instructional designer, and reflected in the design of interaction, the amount of control abdicated to the learner changes. At a reactive level of interaction, the instructional developer retains almost complete control over the content, its presentation, sequence and level of practice. A proactive level of interaction relinquishes much of the developer's control over instruction, as the learner determines what content to encounter, the sequence and how much time to devote to any particular element, and whether additional content will be explored or ignored. In proactive designs, the learner holds a high degree of control over all elements of instruction, and this may not always be beneficial to the learner. The learner is still at the mercy of the content selected by the designer/producer of instructional material and the navigational tools provided to the learner, but within these confinements, the learner exercises complete control. At a mutual level, the highest level of interaction, the system and the learner negotiate control of instruction. The learner engages the instruction and makes decisions, but as instruction proceeds, the system adopts the role of wise advisor (or tyrant) and attempts to structure the instruction for the learner, based on needs revealed by the learner. Thus, the amount of learner control is shared at a mutual level of interaction.

One problem for an instructional developer is to decide when to assert and when to relinquish control. This decision will, in turn, influence which level of interaction may be appropriate to employ in the design of instruction. The issue has moral and ethical overtones. Certainly, it would be inappropriate to set unprepared learners adrift in a sea of learning resources without the skills necessary to navigate their craft, and then expect them to operate efficiently. Learners need to be sufficiently mature, and have access to the necessary problem solving and attack skills to perform successfully in less-structured learning environments. Osman and Hannafin (1992) point out that significant variables in the acquisition and use of metacognitive strategies are the age of learners, previous experience and their belief in their abilities. Programs need to emphasize not only knowledge about strategies, but also knowledge about maintaining and transferring strategies to other settings. Cybernetic systems may be able to "tune" themselves to the metacognitive strategies employed by learners, adjust to them, and advise learners of trends which emerge. Systems can, by advising the learner in an organized fashion about decisions made, promote the development of personal metacognitive strategies.

Decisions about control form part of the art of instructional design. One should not assume that proactive and mutual forms of interaction do not impose external elements of learner control. On the contrary, considerable control of the learner can be exercised by the instructional designer in subtle and passive forms, such as the design of the access structure available to the learner. For example, confusing or obscure icons may discourage learners from exploring associated material in a learning resource. If control is to be given to learners, attention must be paid by instructional designers to the covert elements of a design with may frustrate learners from exercising that control. In other words, control must not only be *given* to learners, it must be *taken* by learners, and design factors may inhibit or encourage their decision to take control.

Although prescriptions regarding learner control in independent learning designs would be premature, tentative advice is available.

General Conclusions About Control

- Control is often used to refer to the selection of content and sequence, but may also include the full range of learner preferences, strategies and processes used by the learner.
- Relinquishing control of the instruction and giving the learner control may increase motivation to learn (Santiago and Okey, 1990; Steinberg, 1977).
- When control of the learning is given over to the learner, so also is the external definition of efficiency. Learner control does not necessarily increase achievement and may increase time spent learning (Santiago and Okey, 1990).
- Learner control may permit students to make poor decisions about how much practice they require, which are reflected in decremented performance (Ross, 1984). On the other hand, metacognitive strategies can be acquired by the learner which will help the learner make more productive decisions (Osman and Hannafin, 1992).

Control Issues Related to Learner Characteristics

- Learners who are generally high achievers or who are knowledgeable about an area of study can benefit from a high degree of learner control (Borsook, 1991; Gay, 1986; Hannafin and Colamaio, 1987).
- Naive or uninformed learners require structure, interaction, and feedback to perform optimally (Borsook, 1991; Carrier and Jonassen, 1988; Higginbotham-Wheat, 1988, 1990; Kinzie, Sullivan, and Berdel, 1990; Schloss, Wisniewski, and Cartwright, 1988).
- The effectiveness of learner control is mitigated by such learner characteristics as ability, previous knowledge of the subject matter, and locus of control (Santiago and Okey, 1990).

Control Issues Related to Program Variables

- Learner control with advisement seems to be superior to unstructured learner control for enhancing achievement and curiosity, promoting time-on-task, and stimulating self-challenge (Arnone and Grabowski, 1991; Hannafin, 1984; Mattoon, Klein, and Thurman, 1991; Milheim and Azbell, 1988; Ross, 1984; Santiago and Okey, 1990).
- Learner control of presentations has been shown to be beneficial with respect to text density (Ross, Morrison, and O'Dell, 1988) and context conditions (Ross, Morrison, and O'Dell, 1990).
- Courseware should be adaptive. It should be able to alter instruction dynamically, based on learner idiosyncracies (Borsook, 1991; Carrier and Jonassen, 1988).
- One opinion holds that learners should be given control over contextual variables such as text density, fonts, and backgrounds, but not over content support variables such as pacing, sequence, and examples (Higginbotham-Wheat 1988; 1990).

Control Issues Related to Practice

- Give learners opportunities to practice using higher-order cognitive strategies, such as metacognitive procedures and mental modelling to promote complex learning and transfer (Osman & Hannafin, 1992; Jih & Reeves, 1992).

- Cooperative learning strategies can be applied to computer-based instruction, but learners may need to learn and practice using collaborative skills for collaborative strategies to be successful (Hooper, 1992).
- Practice should include practice with strategies for learning, not just practice with specific content or skills. Learners can benefit from memory and organizational strategies to make information more meaningful. Metacognitive strategies can promote learning and can be generalized across learning situations, but they must be learned and practiced (Osman & Hannafin, 1992).
- Practice should be available to the learner at any time, and in several forms to satisfy self-determined needs. In prescriptive environments, practice will be imposed often during early stages of learning and less often as time with a particular topic progresses (Salisbury, Richards, & Klein, 1985).
- Practice during instruction should be varied.
- As facility and familiarity with the learning task increase, so should the difficulty of practice. In prescriptive environments, the difficulty level would be managed externally by the instructional designer. In democratic and cybernetic environments the learner may be advised about difficulty levels and productive choices, but the decision will be left in the hands of the learner.
- Practice events should require learners to use information and discover and derive new relationships in information.

These suggestions, however inviting, should be approached with caution. Not only are they tentative, they are also contradictory in some cases. For example, the advice offered by Higginbotham-Wheat (1988; 1990) can be interpreted to mean that learners should influence only variables which have little instructional significance, and be denied control of significant instructional variables. Certainly this contradicts the intentions and findings of many of the other studies cited, as some argue that we need to go beyond objective and prescriptive designs, and embrace generative and constructivist approaches (Jonassen, 1991; Hannafin, 1992). Inherent in these arguments is the concept of control, an issue which will occupy a central position in multimedia research during this decade.

Summary

The classification of interaction for multimedia instruction offered in this paper is temporal and developmental. As instructional design theory advances, and as the development of instructional technologies continues to bluster, the categories offered herein will likely evolve. Certainly our understanding of productive avenues for instructional design and practice will also grow. Increasing attention is being given to democratic and cybernetic environments for learning, and this is, in turn, requiring instructional designers to reconsider the roles played by interaction during instruction.

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Title:

Teaching Collaborative Problem Solving Using Computer-Mediated Communications

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Teaching Collaborative Problem Solving Using Computer-Mediated Communications

Faculties in schools of business are continually challenged to find relevant and effective ways of teaching management theory and practice to their undergraduate and graduate business majors. Besides the traditional content material on management principles, three additional areas of instruction need to be emphasized to adequately prepare these students for the professional roles they will be expected to fulfill in the business world. First, students need to become active learners, applying the principles they have learned. Second, students need practice solving "real world" problems presented in a complex framework. And third, students need experience working together as members of a team engaged in problem solving.

The business case studies that are commonly assigned as group projects in business management courses do serve to meet these educational needs. The typical format of such assignments requires the students to analyze the strengths, weaknesses, opportunities, and threats of a company, then identify strategic issues and formulate recommendations for that company. Students are either given or required to research the information on the history of the company and its industry, the company's mission and purpose, external environment, internal environment, product mix and characteristics, competitive market, and strategies used by the company to meet its goals.

There are some problems associated with these group case study assignments, however. Assigning grades to students can be problematic because the instructor cannot easily ascertain the contribution level of each student to the paper that was handed in. Even when the instructor has students identify their contributions to the report, grading inequities are difficult to avoid. Most instructors adopt the policy of giving all members of the group the same grade, based on the quality of their joint effort. Better teamwork may result, but the problem of grade inequities is not resolved by this approach.

In fact, the "single grade" policy may in and of itself intensify grade inequity problems by failing to provide any consequences for an unequal distribution of work load within the group. Some students will become "free riders," taking advantage of their teammates' determination to get a good grade on the assignment. Other students, who are highly motivated by grade and who lack confidence in their teammates, will take on a disproportionately large share of the assignment to assure that it is completed satisfactorily.

Another reason that all members of the group may not participate equally in work sessions relates to personality differences. Students who are outgoing and self-assured often dominate group discussions; students who dislike competing for the opportunity to be heard or who are uncomfortable defending their opinions tend to be reticent.

A system of microcomputers interconnected with electronic meeting system software was used in this research study as a possible means of overcoming the grading and participation disparity problems associated with group work sessions conducted in face-to-face meetings. Studies published by users of GroupSystems, an electronic meeting system software package developed at the University of Arizona, reported that computer-mediated communications tend to reduce dysfunctional personal interactions such as domination by some group members and participation avoidance by others, as well as increasing productivity for the group as a whole. Another advantage for the instructor is the feature in GroupSystems that provides the ability to print out a transcript of all communication interactions that occurred during the session, identified with each participant's name.

The purpose of this study was to determine the effect of computer-mediated communications on the productivity and the participation pattern of groups involved in collaborative problem-solving activities. The expectation of the authors was that groups of students collaborating on case study analysis assignments would be more productive and would participate more uniformly when communicating with each other through networked computers than in a face-to-face meeting.

Method

Subjects

Twenty undergraduate business students at the University of Northern Colorado were used as subjects for this study. Five females and fifteen males comprised the group. All were enrolled in a senior-level "Strategic Management and Business Policy" class taught as a capstone course for business majors. The class was divided into five groups of four students each by arbitrarily assigning a marketing major, an accounting major, a management major, and one of the remaining students to each group. Each of the five groups was then randomly selected to be either an experimental group or a control group. Three groups were designated as experimental groups and two as control groups.

Materials

Case studies on four different corporations were prepared for use as collaborative problem-solving assignments. Each case study contained information about the history of the company and its industry, the company's mission and purpose, external environment, internal environment, product mix and characteristics, competitive market, and strategies used by the company to meet its goals. Group members were given copies of the case study prior to the group's scheduled meeting to produce a written analysis of the strengths, weaknesses, opportunities, threats, strategic issues, and recommendations for that company. Face-to-face group meetings were conducted in classrooms with the four students seated around a three-foot by five-foot table. The group meetings using computer-mediated communications were held in the Decision Support Center, a meeting room with twenty-one networked PCs running under GroupSystems V, an electronic meeting system software package marketed by Ventana Corporation in Tucson, Arizona. The "Topic Commenter" tool in the package was used, allowing students to enter their comments for each of the six analysis areas (strengths, weaknesses, opportunities, threats, strategic issues, and recommendations) and to view the comments of their teammates.

Procedure

The case study assignments used in this research were included as part of the class requirements and made up a substantial part of the class grade, assuring that students had adequate incentive to participate in the research study and to work seriously at the assignments. Students were told before each work session that all members of their group would receive the same grade--the grade they earned on their analysis paper. An objective of the research was to examine the participation patterns that occur when students have been told that all members of the group will receive the same grade. Therefore, students were not graded individually for these assignments even though the contributions of each student were identified and recorded during the study. Each group met three times, for 75 minutes each, to work on three different case studies. All of the group meeting sessions, including those in the Decision Support Center, were videotaped. The video camera was set up in advance and was left unattended in full view of the students. In the face-to-face group meetings, only the four members of the group were present in the classroom during the group meeting. In the computer-mediated group meetings, one or two system administrators were present in the Decision Support Center room with the four group members. The system administrators were present solely to facilitate use of the electronic meeting system software, staying in the background as much as possible.

The case studies for the four corporations were assigned to the five groups in a different sequence for each group to counterbalance any effect introduced by differences among the case studies in level of difficulty or in students' prior knowledge and beliefs about the corporation or the industry. Before beginning the case study assignments, an orientation session was conducted to familiarize all students with the use of the GroupSystems software and the work stations to assure that students were not inhibited by uncertainty about how to use the technology when working in the Decision Support Center.

The first case study assignment for each of the five groups was a face-to-face session that was used as a desensitization session, giving group members an opportunity to work together completing an assignment like the two that were to follow and to become accustomed to the video camera equipment. The next session for each of the experimental and control groups was also a face-to-face collaborative problem-solving session. The third session for the experimental groups was conducted in the Decision Support Center using computer-mediated communication. The third session for the control groups was conducted as another face-to-face session.

In each of the face-to-face meetings, the group prepared a hand-written report to turn in summarizing the group's analysis of the case by the six required categories. In the computer-mediated meetings, the group handed in the computer-produced printout of their comments segregated into the six case-analysis categories. The reports that were handed in were graded by the instructor and subsequently returned to the students after all case studies had been completed.

The first face-to-face meeting of each of the groups, the desensitization session, was not scored as part of the study data. The videotapes for each of the second group meetings of all five groups (all face-to-face meetings) were transcribed into scripts to facilitate scoring of the group interactions. Similarly, the videotapes of the third face-to-face meetings of the two control groups were transcribed into written scripts. All written materials that were prepared for scoring were edited to substitute numbers for student names and to remove any references to gender, race, or other features that might introduce scoring bias.

Each comment made by a student was scored as being one of three types: T to designate task-oriented comments that related directly to the analysis of the case study, G to designate group process comments that served to direct group effort or provided feedback in group activities related to the assigned task, and S to designate social and other non task-related comments. Within the T category, those comments that contributed directly, in a very focused way, to the task requirements were scored as T-1 comments. Seven videotape transcripts and three computer-mediated session printouts were scored and tallied. In the videotaped sessions, a count was also made of the number of task-oriented comments (T comments) that were interrupted by another group member. In some cases, the second individual talked over the first one's comment. In other cases, the first individual had not expressed a complete sentence or thought, but stopped talking (perhaps to search for a word) and the second individual took the floor.

Results

A summary of the data collected is presented in Table 1. A weighting factor was applied to scale the scores within each group for a standardized session duration, i.e., to 31 minutes, the duration of the shortest session. The three experimental groups were combined into a composite experimental group and the two control groups were combined into a composite control group after verifying homogeneity of variance between the groups (using Hartley's F_{max} test) and normalcy of distribution for each group (using a Kolmogorov-Smirnoff Test of Goodness of Fit).

A t-test of dependent observations was used on both composite groups to compare the difference in the number of T-1 comments (direct contributions to the assigned task). The experimental group showed a significant increase ($p<.05$) in the mean number of T-1 contributions in the computer-mediated sessions over the face-to-face sessions. No significant difference was found in the mean number of T-1 contributions between the two successive face-to-face sessions in the control group.

A t-test of paired variances was used to compare the variance of All T comments (all task-oriented comments) contributed within each group. There was a significantly smaller variance ($p<.05$) in the number of All T comments made in the experimental group's computer-mediated session than in its face-to-face session. No significant difference was found between the variance of All T comments made in the control group's two face-to-face sessions.

Table 1
Summary of Comment Category Scores for Experimental and Control Groups

GROUP 1: Treatment Group

	Duration: 47 minutes Face-to-Face Communication					Duration: 50 minutes Computer-Mediated Communication				
Student	T-1	All T	All G	All S	Total	T-1	All T	All G	All S	Total
1	5	37	7	3	47	19	19	-	-	19
2	17	61	46	2	109	13	13	-	-	13
3	11	63	24	5	92	17	18	1	-	19
4	11	37	11	1	49	10	12	1	-	13
	44	198	88	11	297	59	62	2	-	64
	15%	67%	30%	4%	100%	92%	97%	3%	0%	100%

29 T comments interrupted

GROUP 2: Treatment Group

	Duration: 64 minutes Face-to-Face Communication					Duration: 62 minutes Computer-Mediated Communication				
Student	T-1	All T	All G	All S	Total	T-1	All T	All G	All S	Total
1	0	2	1	-	3	29	29	-	-	29
2	18	102	29	9	140	35	38	3	1	42
3	27	107	48	5	160	37	37	-	-	37
4	15	95	76	7	178	22	22	-	1	23
	60	306	154	21	481	123	126	3	2	131
	12%	64%	32%	4%	100%	94%	96%	2%	2%	100%

31 T comments interrupted

GROUP 3: Treatment Group

	Duration: 31 minutes Face-to-Face Communication					Duration: 50 minutes Computer-Mediated Communication				
Student	T-1	All T	All G	All S	Total	T-1	All T	All G	All S	Total
1	17	51	10	3	64	51	52	-	-	52
2	14	36	15	1	52	36	37	-	-	37
3	5	41	8	4	53	15	16	6	-	22
4	9	33	7	2	42	27	27	-	-	27
	45	161	40	10	211	129	132	6	0	138
	21%	76%	19%	5%	100%	93%	96%	4%	0%	100%

19 T comments interrupted

GROUP 4: Control Group

	Duration: 76 minutes Face-to-Face Communication #1					Duration: 55 minutes Face-to-Face Communication #2				
Student	T-1	All T	All G	All S	Total	T-1	All T	All G	All S	Total
1	15	75	36	-	111	16	48	3	16	67
2	1	7	1	-	8	10	31	2	17	50
3	23	92	21	7	120	12	41	16	18	75
4	10	41	10	1	52	11	36	10	9	55
	49	215	68	8	291	49	156	31	60	247
	17%	74%	23%	3%	100%	20%	63%	13%	24%	100%
		28 T comments interrupted					16 T comments interrupted			

GROUP 5: Control Group

	Duration: 62 minutes Face-to-Face Communication #1					Duration: 48 minutes Face-to-Face Communication #2				
Student	T-1	All T	All G	All S	Total	T-1	All T	All G	All S	Total
1	6	87	17	9	113	4	66	11	32	109
2	16	67	24	11	102	21	87	22	20	129
3	4	35	10	5	50	6	28	12	10	50
4	28	128	70	11	209	13	78	39	30	147
	54	317	121	36	474	44	259	84	92	435
	11%	67%	26%	8%	100%	10%	60%	19%	21%	100%
		37 T comments interrupted					55 T comments interrupted			

Comment Category Codes:

T-1 - Comments that made a direct contribution to the task requirements
(T-1 is a subcategory of All T)
All T- Task-oriented comments that related directly to the analysis task
All G- Group process comments that directed group effort or provided feedback
All S- Social and other non task-related comments

Discussion

The results of this study supported the authors' expectations regarding both hypotheses. Students were more productive in accomplishing task objectives and participated more uniformly when working together using computer-mediated communications. A larger study, using approximately ninety students, is planned for spring semester 1993 to follow up on the promising results of this study.

Several possible reasons for the increase in student productivity are suggested by the data summarized in Table 1. There are almost no group process or social interactions between students who are communicating through the computer network, resulting in a more task-focused work session. The depersonalized nature of electronic communications appears to discourage socialization and group interaction. Another possible reason for the increase in productivity may be related to the number of times that task-oriented comments were interrupted by someone else in the group. The number of interrupts per session ranged from 16 to 55, with a mean of approximately 31. Group process and social comments were interrupted frequently as well, but the interrupts to T comments represent the number of times that an individual was unsuccessful in getting out an idea that was task-oriented.

The competition for the opportunity to speak in face-to-face sessions that is evidenced by the interrupts may also provide a clue as to why not all students participate equally in collaborative problem-solving sessions. Students who are less insistent on being heard will participate less. In a situation where there is not competition for air time, such as in sessions conducted using computer-mediated communications, those same students may dramatically increase their level of participation. Similarly, students who like to assume a leadership role in face-to-face meetings find it more difficult to control and lead a group when they are communicating electronically.

Computer-mediated communications can function effectively as an alternative means of teaching collaborative problem solving, particularly when the instructor would like to be able to grade individual student's contributions. The benefit of increasing task-focused behavior by students is also evident. The authors suggest the use of computer-mediated communications as a supplement to traditional face-to-face problem-solving sessions, not as a replacement. Valuable learning and teamwork experiences are embedded in the social and group process interactions that make up a large share of the communication in face-to-face meetings.

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Title:

Qualitative Research? Quantitative Research? What's the Problem? Resolving the Dilemma via a Postconstructivist Approach

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Qualitative Research? Quantitative Research? What's the Problem? Resolving the Dilemma via a Postconstructivist Approach

Introduction

The "qualitative vs quantitative" debate has been part of the fabric of educational research for some time. (cf. Smith, 1983; Gage, 1989; Rizo, 1991; Salomon, 1991 for various discussions of the debate) At stake in this debate is the issue of whether two worldviews of research can coexist, or if one has to eventually either incorporate or discredit the other. Most of the various papers on this debate have been framed at the methodological level of discussion. In this paper, I would like to take a slightly different turn. I would like to argue that it is more useful to look at this debate in terms of the two overarching philosophical positions that ground the debate over methods. In short, I would like to show that the "qualitative vs. quantitative" debate, played out in foundational terms for educational researchers, is actually a constructivism vs. positivism argument.

When we look at current formulations of qualitative methods in educational research, more traditional notions of straightforwardly applying ethnographic and other anthropological and sociological techniques have been more or less replaced with a call to approaching qualitative research from a constructivist perspective. (cf. Guba, 1992; Eisner, 1992; Duffy & Jonassen, 1991) Furthermore, most issues that surface in an examination of constructivism are actually metonymous to issues that are found in the larger qualitative context, and, given the emerging prominence of constructivism in educational technology research, an analysis of constructivism per se ought to be concretely fruitful to the field. Positivism has arguably been the philosophical basis for most quantitative research in education, (cf. Schrag, 1992; for a recent defense of positivism in educational research) and so is the perfect philosophical counterpoint for constructivism.

When we compare constructivism and positivism, I hope to show that there are actually two different things that are meant when the term "constructivism is used, and this makes any simple attempt at reconciling the larger schism between constructivism and positivism nearly impossible. Furthermore, I hope to demonstrate that the schism in constructivism is a function of an older schism, and that in order to move beyond the framework provided by positivistic thinking, we must adopt one of the senses of constructivism over the other. And finally, I am going to propose that since the "wrong" version of constructivism is the sense most currently in usage by educational researchers, that, starting now, we adopt the label of "postconstructivism" to distinguish the "good" version of constructivism from its "evil twin."

Constructivism and Educational Technology Research

Let me start off by saying that some of my best friends are constructivists. I also would like to acknowledge that constructivism draws much of its energy from the same recent historical trends that have come to produce what we consider to be mainstream qualitative research in education, including holistic ethnography, symbolic interactionism, cultural anthropology, and the like. (cf. Jacob, 1987, for a review of these trends) However, I think it is important for us to realize that most constructivist practitioners assume certain stated and unstated assumptions that ground it very clearly to certain trends of thought, and that unreflectively accepting the basic tenets of these trends can lead us into some troubling consequences.

Merrill (1991) summarizes constructivism as being based on the following assumptions; 1) knowledge is constructed by the learner, 2) learning is a personal interpretation of experience, 3) learning is active, 4) learning is collaborative, 5) learning is situated in real world contexts, and 6) assessment of learning is integrated within the learning context itself. (p. 46) Duffy & Jonassen (1991) acknowledge that "constructivism provides an alternative epistemological base" (p. 8) for research in educational technology. They cite recent work in situated cognition as the basis for much of constructivist theory, (cf. Brown, Collins & Duguid, 1989 for a statement of the basic principles of situated cognition in educational research) contrasting such theoretical work against what Lakoff & Johnson (1980) called the "Objectivist" tradition. When we look at the Objectivist tradition, we find that it is really what we have come to call the positivist position in research. Therefore, it is no surprise that constructivism is deliberately anti-positivistic in its outlook.

While constructivism appears to differ from older, behavioristic models of research, it seems to be perfectly attuned to more current directions in psychology. For instance, Perkins (1991) explicitly links constructivism with information processing theory by noting:

> ...information processing models have spawned the computer model of the mind as an information processor. Constructivism has added that this information processor must be seen as not just shuffling data, but wielding it flexibly during learning - making hypotheses, testing tentative interpretations, and so on. (p. 21)

By linking information processing and constructivism, Perkins brings together contemporary cognitive theory and constructivist theory. This is an important step, because it anchors constructivism within the mainstream of scientific thought in the human sciences. Spiro, et al (1991) continue this thread, by further linking constructivism with schema theory. With its insistence on being more free-form and less centralized, constructivist theory also has a natural affinity to theoretical work in connectionism, (Bereiter, 1991) hypermedia, (Tolhurst, 1992) and multimedia. (Dede, 1992) On a practical educational level, Bagley & Hunter (1992) argue that constructivism is the "glue" that can hold together the combination of technological innovation and restructuring needed in our school systems.

All else aside, the debate about constructivism centers on whether we are willing to take a positivist stance toward research in education as was done in the past, or whether we need a new position. In order to make such a decision, the researcher should be aware of what a position entails, and where it came from. Therefore, we need to focus on where constructivist ideas come from, and why they have such purchase on the imagination of researchers in education and other human sciences.

The Roots of Constructivism

What are the basic tenets of constructivism? Cole (1992) claims that "social negotiation of meaning" and "critical argumentation" (p. 27) are the keystones to the constructivist approach. Cunningham (1991) in his neo-Galilean dialogue between a constructivist and a positivist, has "Salviati" define constructivism thusly:

> Constructivism holds that learning is a process of building up structures of experience. Learners do not transfer knowledge from the external world to their memories; rather, they create interpretations of the world based on their past experiences and their interactions in the world. How someone construes the world, their existing metaphors, is at least as powerful a factor influencing what what is learned as any characteristic of that world. Some would even argue that knowledge that is incompatible with or unaccounted for in an individual's interpretation cannot be learned. (p. 13)

These ideas are quite different from the notions that have guided educational research through most of the twentieth century. What are their historical roots? All talk of cognitive theory and methodology aside, it is reasonable to claim that constructivism is basically grounded in the work of three contemporary philosophers of inquiry methodology - Richard Rorty, Nelson Goodman, and Paul Feyerabend.

Richard Rorty, with his neo-pragmatism, (Rorty, 1982; Trimbur & Holt, 1992) is probably the most influential person in the philosophy of science today, as well as being the heir apparent to Kuhn's tremendously important theorizing on the role of paradigms and paradigm shifting in scientific research. Rorty pushes the idea of the paradigm shift to the extreme with his model of narrative philosophy. In narrative philosophy:

> Rorty shifts the terms from a search for method to a strategy of historicization. He urges us to look at philosophical discourse as language-in-action - not a privileged perspective that holds out the hope of finally moving from speculation to science but simply the stories philosophers tell each other.... To historicize philosophy in this way...means we will no longer possess a universal measure by which to judge knowledge claims and the accuracy with which they represent reality.... To recognize that philosophy is no more and no less than its own narratives is to recognize that we will always get the past that we deserve - not a final definitive version of philosophical problems and issues but the version our present situations calls up. We will have what was there all along - ourselves, our common activities, our attempts to cope with reality. And we will be no worse for our judgements. It is just that our judgements will no longer be concerned with what is true and accurate according to some extrahistorical criteria. (Trimbur & Holt, 1992: 75)

Nelson Goodman's Ways of Worldmaking (1978) reads like a manifesto for the constructivist movement:

> Truth, far from being a solemn and severe master, is a docile and obedient servant. The scientist who supposes that he is single-mindedly dedicated to the search for truth deceives himself. He is unconcerned with the trivial truths he could grind out endlessly.... He seeks system, simplicity and scope; and when satisfied on these scores he as much decrees as discovers the laws he sets forth, as much designs as discerns the patterns he delineates.... Truth, moreover, pertains solely to what is said, and literal truth to what is said literally. We have seen, though, that worlds are made not only by what is said literally but also by what is said metaphorically.... (p. 18)

Paul Feyerabend's (1975) self-styled anarchistic emphasis on the practice of science as opposed to theorizing also strikes a fundamental chord in the constructivist model:

> It is clear, then, that the idea of a fixed method, or of a fixed theory of rationality, rests on too naive a view of man and his social surroundings. To those who look at the rich material provided by history, and who are not intent on impoverishing it in order to please their lower instincts, their craving for intellectual security in the form of clarity, precision, 'objectivity', 'truth', it will become clear that there is only one principle

> that can be defended in *all* circumstances and in *all* stages of human development. It is the principle: *anything goes*. (P. 28, italics his).

Guba (1992) explicitly links Feyerabend to his project of relativism which Guba says " ...is an essential element in defining the ontological and epistemological presuppositions of the constructivist inquiry paradigm of which I am a proponent." (p. 17) Eisner, (1992) whose critical version of qualitative methodology is akin to Guba's model of constructivism, draws heavily on Rorty and Goodman in his attempt to critique objectivity in a postpositivist frame. Therefore, we can assume that Rorty, Goodman, and Feyerabend are central figures in the emerging constructivist-qualitative paradigm developing and growing within educational research.

What are the common issues that unite these three foundational constructivist thinkers , and how can we examine those issues to help understand the basic tenets of constructivist thinking? Essentially, Rorty, Goodman, and Feyerabend all share a concern for the historical side to human inquiry, and this is no accident. This is because all three of them see themselves as members of the pragmatist tradition, a tradition that Pepper (1942), in his review of metaphysical positions, labeled "contextualism". Contextualism, furthermore, took its root metaphor from the idea of the historical event. Pragmatism has always looked to the context of practice, in historical and cultural terms, as the basis for resolving issues of meaning. (cf. House, 1991; Cherryholmes, 1992; House, 1992 for a discussion of the role of pragmatism vs realism in scientific inquiry in educational research) Therefore, we can conclude that constructivism, as articulated in educational research settings, is a species of pragmatism. This link to pragmatism will ironically provide us with the means to move from constructivism to postconstructivism, since we will make that move by linking the concerns expressed in constructivism to the ideas of the philosophers who formulated pragmatism in the first place.

Steps toward a Postconstructivist Model

The path to a postconstructivist model of educational research is based on the split within pragmatism that has shaped that philosophical discipline from its outset. Pragmatism is a movement with two founders - an actual founder (C.S. Peirce) and an expedient founder (William James). Many of the problems that arise in pragmatism are based on the fact that the ideas of the actual founder and the expedient founder are different in important ways.

Let us start with the expedient founder of pragmatism - William James. In 1898, in a lecture at the University of California, James stated his version of pragmatism in such a way that the ideas caught the imagination of the American intellectual community for decades to come. Even though James was careful to acknowledge that his good friend, Charles Peirce, was the founder of pragmatism, few people actually looked at Peirce's ideas. Instead, they followed James's dicta. James's version of pragmatism is fairly simple. He held that pragmatism was a means for determining the truth of certain claims. That method works as follows (James, 1948):

> "Grant an idea or belief to be true," it says, "what concrete difference will its being true make in any one's actual life? How will the truth be realized? What experiences will be different from those which would obtain if the belief were false? What, in short, is the truth's cash-value in experiential terms?"
> The moment pragmatism asks this question, it sees the answer: True ideas are those that we can assimilate, validate, corroborate and verify. False ideas are those we cannot. That is the practical difference it makes for us to have true ideas; that, therefore, is the meaning of truth, for that is all that truth is known- as. (pp.160-161; italics his)

Now, let us compare James's maxim on the pragmatic notion of truth with the Pragmatic Maxim. This Maxim, first published in 1878 and pretty much ignored thereafter, is Peirce's definition of pragmatism (Peirce, 1955):

> Consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object. (p. 31)

Granting that the above quote is hard to understand, let us look at a passage where Peirce explicates his maxim:

> ...the whole meaning of an intellectual predicate is that certain kinds of events would happen, once in so often, in the course of experience,

> under certain kinds of existential conditions - provided it can be proved to be true. (p. 273; italics his)

And elsewhere:

> But of the myriads of forms into which a proposition may be translated, what is that one which may be called its very meaning? It is... that form in which the proposition becomes applicable to human conduct, not in these or those special circumstances, nor when one entertains this or that special design, but that form which is most directly applicable to self-control under every situation, and to every purpose. That is why he locates the meaning in future-time; for future conduct is the only conduct that is subject to self-control. (p. 261)

Finally, let us turn to Murphy's (1990) paraphrase of Peirce's pragmatic maxim, which Murphy calls Peirce's Principle of Meaning:

> If one can define accurately all the criteria governing uses to which a predicate can be put, one will have therein a complete definition of the meaning of what it predicates. (p. 46)

Compare this now with Murphy's (1990) paraphrase of James's theory of truth:

> What is true in our way of thinking is the production of beliefs that prove themselves to be good, and good for definite, assignable reasons. (p. 57)

Peirce and James mean two very different things by pragmatism. Peirce saw the Pragmatic Maxim as a way of determining the logical nature and consequences of certain beliefs in terms of the practical consequences of holding those beliefs. James, on the other hand, saw the Pragmatic Maxim as a method of determining the truth of a given proposition. For Peirce, belief claims were contextual and provisional, yet truth claims were more general and logically accessible. For James, truth claims, not just meaning claims, were provisional and contextual. Because Peirce held that there can be truth over and above what we might think to be true, he is ultimately a realist. Since James always grounds truth claims in contextualist activities, he is ultimately a relativist. And the gap between the two is quite vast.

The pragmatism that informs Rorty, Goodman, and Feyerabend, and thus ultimately the constructivists, is derived from James. For instance, Rorty (1982) turns explicitly to James to make the following points about James's view of truth:

> James's point was that there is nothing deeper to be said: truth is not the sort of thing that has an essence.... Those that want truth to have an essence want knowledge, or rationality, or inquiry, or the relation between thought and its object, to have an essence. Further, they want to be able to use their knowledge of such essences to criticize views they

> take to be false, and to point the direction of progress toward the discovery of more truths. James thinks these hopes are in vain. (p. 162)

And this version of understanding the nature of truth is at the very heart of the constructivist program. As we saw earlier, the constructivist holds that we construct knowledge. What is knowledge but those things that we hold to be true? Furthermore, the constructivist rejects the idea that there is a single foundation for basing the pursuit of truth on, and so the question of truth becomes instead an exercise in, what we see over and over again, the "social construction of reality."

Are we doomed to this project of making multiple realities, of just telling each other stories, and letting the question of truth be settled by whose story is more interesting, or whose will is stronger? If we adhere to the Jamesean perspective, then this seems to be the case. But there is an alternative for inquiry - to return to Peirce's initial statements and take them in a different direction.

Postconstructive Research - A Vision

We are at last finally free to talk about qualitative research in general, and thereby finally address the question outlined in the title. Constructivist theory has made significant inroads in the educational research community by offering a vision of research and theory that seems substantially different from the prevailing positivistic vision based on more traditional models of scientific inquiry. Constructivism appeals to the desire of many in the field to be freed from the constraints of a positivistic model of inquiry. (cf. Glesne & Peshkin, 1992; Lancy, 1993) It cannot be over-emphasized, though, that the fundamental point of constructivism is to deliberately refute positivistic positions. By taking this tack, constructivist ideas are necessarily grounded in the same problematic that the positivist tradition was grounded in; namely, a concern for establishing the proper conditions for gathering and using knowledge. This grounding in the pursuit of knowledge characterizes the basic task of modernist thinkers. (Lyotard, 1979) But the modernist problematic is no longer appropriate. The predicament faced by most constructivists is that they sense a need to shift beyond a modernist perspective, but they attempt to do so by addressing the matter in a modernist fashion.

There is no escaping the fact that we are now living in a postmodern world. Lyotard (Lyotard, 1979; Johnson, 1992) has declared that the postmodern condition is based on the notion that there is no longer a "grand narrative" that defines a single vision for culture. We have to abandon the search for a single perspective through which we can formulate a single best way of doing inquiry. Gergen (1992) shows us that postmodernism involves a turning away from the Enlightenment, with its insistence on individual cognition, rational order, and correspondence models of inquiry, toward a new sensibility of collective rationality, action, and examination of phenomena as "texts" instead of repositories of fact or instantiations of theory. Thinkers such as Heidegger (Guignon, 1992) and Baudrillard (1988) have emphasized that language and its rhetorical nature play a crucial role in the ways that we understand our world, thereby clarifying the "textness" of the world.

Both James and Peirce would appreciate the move in inquiry towards the postmodernism described above. But their characterizations of the situation would be quite different. James leads us away from the pole of strict objectivity by positing a relativist and ultimately subjective model of truth and therefore inquiry, while Peirce rejects the subjective vs objective duality altogether. It is this rejection, which is far more radical than any project that James or the constructivists would suggest,that finally allows us to build the bold and radical vision of qualitative research that education needs in order to function properly in a postmodern setting.

As my fundamental move in this paper, I would like to show how Peirce gets out of the subjective-objective trap, and then show the consequences of this move as the basis for a genuinely qualitative model of educational research, one that does not slip either into the trap of an "anything goes" relativistic subjectivism or the "just the facts" pseudo-scientific objectisitic positivism that has strangled the vitality from educational research. (cf. Shank, 1987; Shank, 1988; Shank, 1990; Shank, 1992; Shank & Cunningham, 1992)

The key to creating a pragmatically-informed model of inquiry is to realize that pragmatism, as Peirce conceived of it, was a totally radical departure from the Enlightenment scenario. That scenario was established by the work of Descartes. In point of fact, the subjective - objective split that haunts modernism is a direct consequence of the Cartesian method of inquiry, known as the method of doubt.

Briefly, the method consists of deliberately doubting the truth of anything, until we arrive at something we cannot doubt; namely, the famous "cogito ergo sum" or "I think, therefore, I am." This method requires both a subjective observer and the objective realm of the observed. This method also creates an unbridgeable split between the observer and the observed, keeping the observer always out of the very reality of that he/she is trying to observe. Peirce realized that this split was a function not so much of Descartes's intended worldview, but of his method instead. So, in order to create a post-Cartesian worldview, one that is free from the subjective - objective split, we need to create a new method.

To make a long story short, the Pragmatic Maxim was a direct consequence of Peirce's efforts to replace the Cartesian method. Peirce realized that Descartes's method of doubt was flawed because the doubt that Descartes engendered was not genuine. Peirce chose to focus on genuine feelings of doubt that we feel, and the means that we try to alleviate them and move back into states of belief. This fixation of belief in the face of genuine doubt was the basis for all inquiry, in Peirce's view. So long as we have no reason to doubt either our senses or our current understanding of things, says Peirce, then we have no reason not to suppose that they are true. As soon as something intrudes into our current state of understanding, though, we realize that we were not right after all, and that truth is different from what we had held it to be. That instance from experience, furthermore, is a clue that the way that we looked at reality was not quite right, and by that fact alone, we now have a new clue as to the ultimate nature of reality. Through this correctable process, held Peirce, we co-evolve, with the help of experience, a significant understanding of reality, one that we have no reason to suppose that is not true, but one that we cannot feel smugly is correct.

Inquiry, then, becomes an act of "reading" experience to gain more and more clues about the nature of reality. We treat the items of experiences as neither objective facts whose truth we can grasp in an unmediated way, nor as subjective opinions whose truth is simply a matter of what we want it to be. Rather, we treat those items as signs of reality. In order to read them, we have to live in the gap between the objective and the subjective, and we soon come to see that the gap as illusory.

Our postconstructive model says that we do not construct reality, because reality itself is so rich and significant that all we need to do is to read it. But we need to enrich our current conceptualization of "reading." Reading is not a process of extracting information from a printed page, nor is it the creation of meaning. Reading and writing, telling and hearing, and narrating and understanding, are all the same process. We listen to and read stories in an attempt to try to understand the nature of reality a bit better, but we tell and write them for the same purpose. To say that we read and write to get access to reality sounds silly, but to say that we write and tell in order to create reality is just as silly. We can finally argue that the act of "reading" will change both us and reality, since we are both co-evolving. We have the tenets of experience to keep us straight, and the Pragmatic Maxim to keep us from slipping into models of inquiry that lead us away from reality.

What would such a model look like in practical terms? It is legitimately postmodern, in that it realizes that there is no one way to look at reality. But it rejects the notion of dependence on the observer and replaces it with a model of the inquirer as a participant. When we construe the inquirer as a participant, we see that he/she is not looking at reality from some outside or privileged position, but instead is in the middle of reality. In fact, Peirce would claim that all inquiry begins with us being in the middle of some already existing world, and that our first act is to try to make sense of that world. The constructivist would say that we find ourselves in a situation where we have to make meaning in the sense of imposing meaning on a situation which has no meaning until we put it there. Remember James's old dictum of the "buzzing, booming confusion" we experience until we impose order on it? Furthermore, again following James, the order that we impose then becomes true so long as that truth is useful to us to maintain the order we have already imposed. Pretty soon, we find ourselves in the dilemma of being in a situation where any meaning is totally a product of what we have put there. What does the world become, then, besides ourselves? And what is instructional design under the aegis of this thinking but the use of one's intellectual will to impose a worldview on others, which is then claimed to be true because it conforms to the will of the design creator? And what does educational technology become, then, except for a means to enhance this imposition process? What about the constructivist's claim that the creation of knowledge needs to shift from the designer and instructor to the student? What is this other than the shifting of the will to either the individual or the collective student? At its very best, constructivism with its inherent relativism and dependence of the subjective stance of designers and students, becomes a way to shift from an individual to a collective solipsism.

As Peirce pointed out in his famous essay on the fixation of belief, the only way to maintain a belief which we do not want to abandon is to hold onto it with tenacity and to make sure we do not find ourselves in any kind of circumstantial situation where that belief might get challenged. The path of constructivism leads inevitably to the championing of the will, rather than the intellect, as the supreme arbiter on what counts as knowledge.

The postconstructivist alternative is to accept that we cannot impose our will freely on reality, but that we are not slaves to some configuration of reality. It accepts the fact that we are always in reality, and in relation to all other systems in reality. And that every experience has significance as a part of the whole picture of reality. And that reality is not constructed, or a simple set of principles underlying a complex surface, but is instead intelligible on its own terms. But we accept that the terms of intelligibility of reality are not directly translatable into human terms. We have to treat experiences as signs of the nature of reality, as answers to questions we are not sure how to ask. We have to shift our model of the inquirer away from the prospector model of the positivist, who seeks to find the nuggets of truth under the welter of experience, and the novelist model of the constructivist, who seeks to create truth out of what seems to be available. The postconstructivist is postmodern in realizing that there any many paths of inquiry, but unlike the constructivist the postconstructivist does not hold that we impose the order we seek by following many paths. The model of the postconstructivist follows along semiotic lines, where the inquirer realizes that experiences are signs of order and understanding and meaning and that they have consequences not just in and of themselves but of how they are taken as signs. The model for the postconstructivist is that of a detective, treating experiences as clues and omens and symptoms of an order that represents a rich and complicated reality that we can only understand within a process of participation as part of reality itself. The postconstructivist turns away from knowledge per se as the starting point of inquiry, and acknowledges that there is just as complex and as important an inquiry based on increasing understanding, that an inquiry of understanding is just as potentially systematic as an inquiry of knowing, and that any real inquiry of knowing depends on an inquiry of understanding.

So where have we ended up, on this process of going beyond constructivism? I want to charge that educational technology is in a unique position of being able to help further an inquiry into understanding. By developing new technologies and new tools, we can help students not just make meaning out of a jumble of data, but to look at their experiences in a participatory way and to combine and test patterns and clues, and to derive consequences from these clue patterns, and to push forward with new and unique insights. I feel that this was the intended mission of constructivism in the first place, but it cannot achieve that mission unless it gives up the notion that the order it seeks is simply imposed by the subjectivity of the inquirer.

Let me conclude this entire piece and hopefully bring my points home in a concrete way by telling you about a computer program that John Ross and I designed to help illustrate a semiotically informed model of inquiry. We called the program ART, which is short for the Abductive Reasoning Tool. The idea behind ART is that there are potentially a myriad number of insights that can be drawn when we juxtapose two statements in an arbitrary fashion. We start with a topic statement, which the person types in. Then, the computer randomly accesses one of over a thousand generic wise sayings, which is physically juxtaposed with the initial topic and called the "reflection" statement. The whole point of the process is that the inquirer feels a compulsion to link those two statements as a single meaningful whole, and that such a link will give the inquirer a new insight into the topic. We felt that the random linkage allowed the inquirer to explore different avenues for insights than he/she might ordinarily pursue. By realizing that the linkage is hypothetical and under no burden to be "true" we are allowed to pursue an inquiry of understanding that does not generate any new knowledge. We would not be able to take this stance from a constructivist perspective, since we would be compelled to be making some reality claim, or showing how the linkage we create is in some sense "true".

So, I turned to the program to ask: "How can postconstructivist ideas help clarify the qualitative vs. quantitative debate?"

Here is the actual reflection statement: "Our intelligence wraps in obscurity the simple natural truths in order to get credit for them."

I leave the task of drawing insights to you.

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Title:

Varying the Narration Presentation Format and On-Screen Character-Narrator Relationship in an Instructional Science Film

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Abstract

The purpose of this study was to examine how learning, attitudes, and mental effort are affected by changing the verbal information presentation format and relationship between the narrator and on-screen character in a junior high school-level science film. Twenty seventh-grade science classes (N=441) were randomly assigned to one of five treatment groups. Each class viewed a 16-minute film about a girl their own age designing and carrying out an experiment with plants. The visual channel remained the same for each group, but the narration was changed to create versions with an adult or teen narrator presenting the information in story or direction format. Altering the age and presentation format of the narrator also changed the relationship between the narrator and on-screen character. Recall and comprehension of information was measured along with self-reported amount of invested mental effort, interest, and confidence in doing plant experiments. Results indicated students learned more when the information was presented in story format, especially when the narrator was their own age. Females indicated a higher level of interest in the film and confidence in doing plant experiments. A gender by narrator "age" interaction for amount of invested mental effort was also observed. Various ideas are advanced for explaining posttest results and survey data, including the effects of peer role models and dual-code information processing. Implications for future instructional film research are discussed.

Introduction

Films and videotaped instructional programs serve many purposes in junior and senior high school science classes. Introducing new material, explicitly teaching scientific concepts and knowledge, reviewing important ideas, reinforcing concepts discovered, and presenting data to be analyzed as part of a scientific investigation are just some of the ways video and film are utilized in the classroom. Virtually all secondary education science classrooms have access to at least one television and VCR, and most science teachers regularly use videotaped science programs (Corporation for Public Broadcasting, 1984). As the number of preexisting science films become available in the more affordable VHS format, many teachers are finding it easier to integrate a wider variety of videotaped programs into their curriculum.

Although the use of televised programs in secondary education science classrooms is common, researchers are still unclear as to exactly what kinds of production variables significantly contribute to learning from instructional television (Mielke, 1983). Many instructional film variables have been experimented with in the past, but too few studies have measured the effects of altering production variables on learning. Since television is already being used extensively in many classrooms, and the acquisition of skills, knowledge, and attitudes can be facilitated by a well-designed and produced video presentation, a more comprehensive understanding of specific factors affecting how and why students learn from an instructional video program is in needed (Kozma, 1986).

The effects of manipulating an important production variable on learning from an instructional film was the primary focus of this current study. Since most of the information to be learned by the viewers of instructional films is explicitly stated in the narration, it is important to investigate factors that affect how the narrated information is studied and learned. This experimental study was conducted to determine if varying the narration presentation format as well as the narrator and central on-screen character (OSC) relationship in a junior high school-level science film had an effect on achievement, amount of invested mental effort (AIME), and attitude.

The different narration presentation formats and narrator-OSC relationships were obtained by altering the audio channel of a commercially produced science film. The film was chosen because it is a key film in a popular series of films used in junior high science classes, and because the film had only one on-screen character who appeared to be the same age as the intended audience. The 16 minute film focused on a teenage girl designing and carrying out an experiment to determine the effects of different colors of light on plant growth.

To create the five experimental versions, the same general text of the narration was used, but the narrator age and person "voice" (first, second, or third person) combination was different for each version. The following is an example of a line of narration text that changed for each version:

First person voice: "When **I** select a procedure for measuring a factor in **my** experiment, here height and leaf count, **I** am making an operational definition."

Second person voice: "When **you** select a procedure for measuring a factor in **your** experiment, here height and leaf count, **you** are making an operational definition."

Third person voice: "When **Sarah** selects a procedure for measuring a factor in **her** experiment, here height and leaf count, **she** is making an operational definition."

The different relationships between the narrator and OSC as well as the different narration presentation formats can be summarized as follows:

Film Version: Narrator Age/Voice	Narrator-OSC Relationship	Narration Presentation Format
Teen Narrator First Person (TN1P)	Same	Story
Teen Narrator Second Person (TN2P)	Probably the same	Directions
Teen Narrator Third Person (TN3P)	Different	Story
Adult Narrator Second Person (AN2P)	Probably different	Directions
Adult Narrator Third Person (AN3P)	Different	Story

Three types of depended variables were measured. Learning the information was the primary dependent variable. Subjects responded to multiple choice and constructed response items measuring the recall and comprehension of general and specific information and procedures. Attitudes were also measured. These items included self-reported measures of interest and confidence in doing tasks similar to the ones presented in the film. The final dependent variable was a self-report on how much mental effort was invested in the act of trying to learn from the instructional film.

Method

Subjects

The students from twenty different 7th grade science classes across three junior high schools were the subjects for this study (N=441). The three schools were from the same school district located in a large southwest metropolitan area and had similar demographic profiles. Since science is a requirement for all 7th grade students, the entire mainstreamed 7th grade population for each school was represented in the sample.

Procedure

Each version of the 16-minute televised film was presented to 4 randomly assigned classes. Before viewing the videotaped film, the teacher for each class read a script indicating that the film would present material covering the scientific method and experimenting with plants. Students were also informed that a posttest covering the information would be administered immediately following the film and that performance on the posttest would be graded for points. The program was shown on a 21-inch color video monitor at the front of each classroom. Immediately following the viewing, students were given an attitude survey followed by a posttest covering the information presented.

Criterion Measures

The posttest consisted of 11 multiple choice and 9 constructed response questions covering the recall of general and specific information, various procedures presented, and information comprehension (reliability=.69). All information tested was presented visually and/or given in the text of the narration.

The attitude survey consisted of questions measuring interest, feelings of confidence toward performing science experiments, and four questions measuring the amount of invested mental effort. These mental effort questions were derived from the questions used by Salomon (1983,

1984) to measure self-reported invested mental effort and included items such as "I tried hard to learn from this video," and "Throughout the video, I concentrated hard on what was said by the narrator." Students responded to all survey items using a four point Likert-type scale with 4 representing "strongly agree" and 1 representing "strongly disagree." Responses to each of the four mental effort questions were added together to provide a maximum 16 point score for self-reported amount of invested mental effort. A reliability test on these four questions yielded a Cronbach alpha of .66.

Design and Data Analysis

This study utilized a posttest-only control group design. The independent variables included:

1. Adult versus teen narrator
2. "Story" versus "directions" narration presentation format
3. Different narrator-OSC relationships
4. Viewer gender

The dependent variables consisted of posttest performance, amount of invested mental effort, interest, and degree of confidence in designing experiments.

Analysis of variance tests using a 5 (version) x 2 (gender) factorial design with subjects nested within classes nested within versions was used to analyze the data among groups for all dependent measures (N=20 for statistical purposes). Single degree of freedom contrasts were used to determine if differences existed between adult and teen versions as well as first, second, and third person versions. Pearson's *r* test of correlation was used to analyze the relationship between posttest performance and amount of invested mental effort, interest, and confidence in performing experiments.

Results

Significant findings for each independent variable follow:

Narrator "Age"

ANOVA results indicate a significant main effect for the 5 versions, F(4,15)=4.45, p<.05. The means for posttest scores by gender are reported in **Table 1**. ANOVA single degree of freedom contrasts for posttest achievement scores indicate a significant overall difference between the adult versions (M=11.51) and teen narrator versions only when the teen narrator first person version is included in the teen narrator group (M=12.73), F(1,15)=7.10, p<.05.

Please insert Table 1 about here.

Comparing posttest scores between subjects viewing the adult and teen narrator versions excluding the teen narrator first person version (a crossed design) did not yield significant differences. Comparing posttest scores for subjects viewing the second person adult and teen narrator versions did not yield significant differences either. When posttest scores for the third person versions were compared, the students viewing the teen narrator version (M=13.49) scored significantly higher than students viewing the adult narrator version (M=11.69). Figure 1 illustrates posttest differences between the adult and teen narrator second and third person versions.

Please insert Figure 1 about here.

ANOVA results indicate a significant gender by narrator "age" interaction (p<.001) for AIME. Contrasts revealed this interaction consisted of higher teen narrator version AIME scores (M=11.46) than the adult narrator version AIME scores (M=10.82) reported by females and lower teen narrator version AIME scores (M=10.32) than adult narrator version AIME scores (M=11.10) reported by males, F(1,15)=28.83, p<.001. Figure 2 illustrates this significant interaction. It is interesting to note that all four questions used to determine self-reported amount of invested mental effort displayed the same type of significant differences when analyzed separately.

Please insert Figure 2 about here.

ANOVA results also indicated a version main effect for the survey item "If I had the material, it would be easy for me to design and carry out an experiment even more complicated than the plant experiment." Contrasts revealed the subjects who viewed the teen narrator versions reported a significantly higher level of confidence in being able to do complicated experiments (M=2.41) than the subjects who viewed the adult narrator versions (M=2.12), F(1,15)=11.87, p<.01.

Narration Presentation Format

ANOVA contrasts revealed significant differences in posttest achievement scores for subjects viewing the second person versions (M=11.48) and third person versions (M=12.59), F(1,15)=6.16, p<.05, as well as second person versions versus all the other versions (p<.05). Tukey's HSD pairwise comparison test revealed significantly higher (p<.05) scores for the teen narrator first and third person versions over both second person versions (See Figure 3).

Please insert Figure 3 about here.

Narration-OSC Relationship

Single degree of freedom contrasts revealed no significant differences between subjects viewing the first and third person teen narrator versions.

Gender

The average posttest score for female subjects was higher than the average posttest score for male subjects. This main effect for gender approached significance, F(1,15)=3.60, p=.077.

ANOVA results also indicated a significant main effect for gender and AIME, with females reporting a higher amount of invested mental effort (M=11.19) than males (M=10.6), F(1,15)=17.7, p<.001.

A gender main effect for the survey item "This video program was interesting" was determined by ANOVA, with females indicating a significantly higher level of interest in the film (M=2.4) than males (M=2.2), F(1,15)=4.33, p<.05. Females also indicated a higher level of agreement with the statement "I would like to do plant experiments in science class," with a mean score of 2.75. The mean score reported by males for this survey item was 2.43, indicating a highly significant difference, F(1,15)=8.91, p<.01.

Pearson's *r* test for correlation indicated there were significant correlations between posttest performance and reported amount of invested mental effort, $r=.24$, $p<.01$, and between posttest performance and interest, $r=.14$, $p<.01$. Confidence in designing more complicated experiments and posttest performance correlated significantly as well, $r=.26$, $p<.01$.

The major findings in this study are summarized in Table 2.

Please insert Table 2 about here.

Discussion

The most important finding in this study was the difference in posttest achievement due to narration presentation format. Junior high students recalled and comprehended more information when it was presented in story format, particularly when the narrator was close to their own age. These results might be explained in light of the way both audio and visual channels of information are believed to be processed, as well as the influence of peer role models.

Like most instructional films, the program used in this study presented information in both the audio and visual channels. These channels correspond to the verbal and visual stimuli represented in the integrated dual-coding model of learning (Paivio, 1986). Even though the information presented in all five versions was essentially the same, the visual images corresponding to the information may have meant something different to the viewers depending on the version.

In the first and third person versions, the narrator described what the central character was doing. The narrator was telling her story. In the second person versions, the visual images may have been perceived as examples for the information presented. The narrator never acknowledges the OSC, consequently the viewers may have perceived her role as simply one of providing examples for the information being presented in the narration. If this were the case, the viewers may have been perceiving the verbal and visual stimuli more separately in the second person versions than the other versions. They may have been more conscious of the differences in information presented in the verbal and visual modes, and they may have had a more difficult time processing both channels of information.

Baggett (1984) and others have described the importance of presenting visual and auditory information simultaneously for the effective recall of information presented in instructional films. It is possible that the information presented in the second person versions was not processed at exactly the same time as the other versions since the viewers may have been mentally switching between information and examples. Baggett and Ehrenfeucht (1983) determined that, although more processing time is allowed when visual and verbal stimuli in a film are presented separately, the most effective recall strategy is to present the information simultaneously. These results may be explained in light of the integrated dual-coding model approach to information storage and recall. It is conceivable that, when verbal and visual stimuli are presented as a story, the learner comprehends both channels of information at exactly the same time, thus aiding in the development of mental connections between the visual and verbal stimuli. This idea is consistent with the findings of Mayer and Anderson (1991). Although the mechanisms underlying the integrated dual-coding model are not clearly understood, it is reasonable to assume that a difference in the perceived relationship between the verbal and visual stimuli would result in different types and amounts of mental connections established.

Although quite speculative, it seems natural that the ideas and ramifications of Paivio's integrated dual-coding model approach should be applied to instructional films and instructional television since the presentation of visual and verbal stimuli are the modus operandi for television and film media.

Higher posttest scores for the teen first and third person versions as well as reported higher levels of confidence in performing difficult experiments after viewing the teen narrator version. might be explained by the effectiveness of same-age role modeling by the teen narrator. Role model research has indicated that adolescents in particular respond positively to the use of peer role models in academic settings.

Since the narrator and OSC were both female, the higher levels of interest and AIME reported by female viewers are not surprising. Beyard-Tyler and Sullivan (1980) demonstrated that seventh grade students prefer stories in which the protagonist is their same gender. It is reasonable to assume that the females in this study preferred the female protagonist, conversely the males might have preferred a male narrator and/or OSC. Even though research indicates lower confidence and interest in science reported by females at this grade level (Linn and Hyde, 1989), females in this study reported significantly higher levels of interest in this science-content film. These results illustrate the potential for using media to help promote higher levels of science interest in females.

The significant correlation between the amount of invested mental effort and information recall and comprehension supports the work Salomon and others have done to determine how hard people try to learn from various media and how much they actually do learn. The narrator "age" by gender for amount of invested mental effort interaction was an unexpected occurrence. It is possible that the males felt the credibility of the adult narrator was higher than that of the teen narrator so they concentrated harder on what was going on in the film and found the information easier to understand. In any case, the gender main effect and interaction for amount of invested mental effort illustrate the need to look at other production factors involved in connecting the presentation content with the audience.

The results from this study indicate that learning, amount of invested mental effort, interest and confidence are affected by simple changes in the presentation of narrated information in a junior high school-level science film. Many questions were raised as a result of this study. Future research in this area might include determining whether information presented in first or third person voice really is interpreted as more of a story format than second person voice. It would also be interesting to see how the results might differ if a male narrator and OSC were used in a similar film. It could also prove important to determine if different presentation formats affect the recall and comprehension of information presented only in the visual channel.

Since the use of video-taped films are widespread in science education, more research dealing with film and video information presentation variables is needed. To ensure the highest degrees of effectiveness, efforts should be made to apply current research findings to the development of new instructional films.

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Table 1.

Mean Posttest Scores by Gender

Narrator	Females	Males	Total
Teen			
First Person	13.56 (2.61)	12.98 (3.43)	13.27 (3.04)
Second Person	10.98 (3.60)	11.98 (3.74)	11.42 (3.67)
Third Person	14.25 (3.24)	12.71 (3.95)	13.49 (3.66)
Adult			
Second Person	11.95 (3.08)	11.23 (4.02)	11.53 (3.66)
Third Person	12.79 (3.46)	10.64 (3.73)	11.69 (3.74)
Total	12.57 (3.42)	11.84 (3.85)	12.20 (3.66)

Note. Total N=441 with 35-53 per cell.
Standard Deviations in parentheses.
Maximum posttest score = 20.

Table 2.

Summary of Results

Independent Variable	Results
Narrator "Age"	Students viewing the third person versions recalled and comprehended more content when the narrator was their own age.
	Students were more confident they could do more difficult experiments on their own when the narrator was their own age.
	Females reported higher AIME for the teen narrator versions, while males reported higher AIME for the adult narrator versions.
Narration Presentation Format	Students recalled and comprehended more content when the narration was presented in "story" format (first or third person).
Gender Differences	Females reported higher AIME than males.
	Females were more interested than the males in the film.
	Females were more interested than males in doing experiments in class similar to the one demonstrated in the film.

Figure 1. Mean Posttest Scores by Narrator "Age"

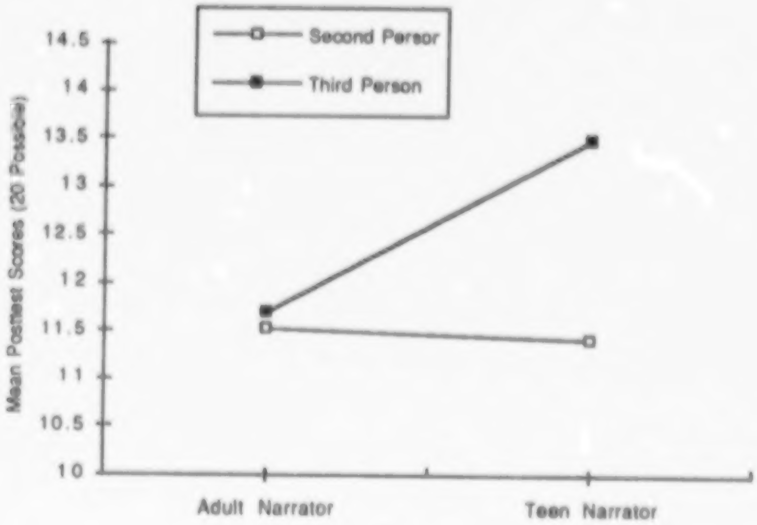

Second Person
Third Person
Mean Posttest Scores (20 Possible)
14.5
14
13.5
13
12.5
12
11.5
11
10.5
10
Adult Narrator
Teen Narrator

Figure 2. Narrator "Age" by Gender Interaction for AIME

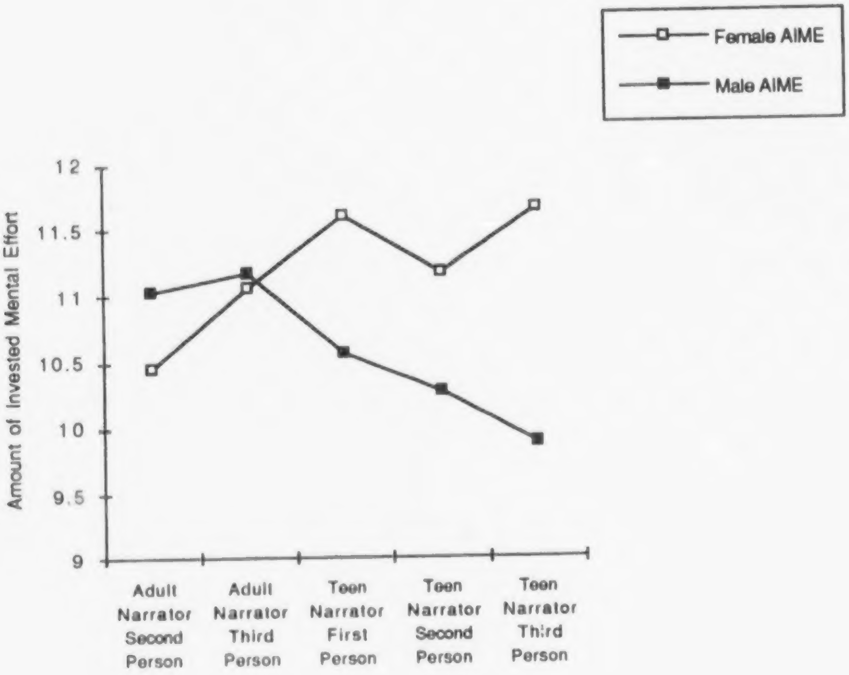
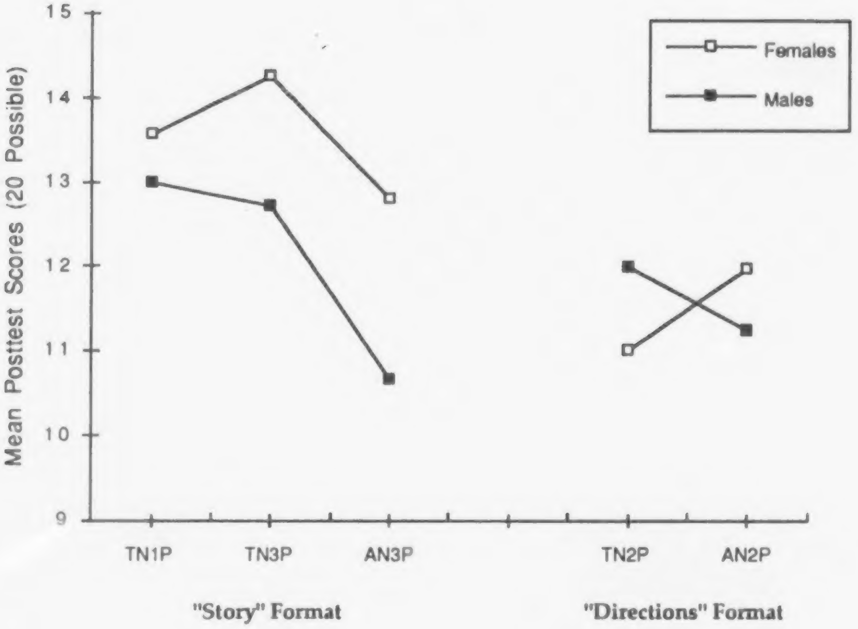

Female AIME
Male AIME
Amount of Invested Mental Effort
12
11.5
11
10.5
10
9.5
9
Adult Narrator Second Person
Adult Narrator Third Person
Teen Narrator First Person
Teen Narrator Second Person
Teen Narrator Third Person

Figure 3. Mean Posttest scores by Narrator Presentation Format.

946 047


15
14
13
12
11
10
9
Mean Posttest Scores (20 Possible)
Females
Males
TN1P
TN3P
AN3P
TN2P
AN2P
"Story" Format
"Directions" Format

Title:

A Pilot Study: Comparing the Use of Computer-Based Instruction Materials and Audio-Tape Materials in Practicing Chinese

Authors:

Ka-fai (Stewart) Shiu
Sharon E. Smaldino

A Pilot Study: Comparing the Use of Computer-Based Instruction Materials and Audio-Tape Materials in Practicing Chinese

Much of the research has already indicated that both computer-based and audio tape materials can increase students' performance in learning a foreign language. Seldom has there been a comparison of the two materials in helping students to practice the skills associated with the language. This present pilot study presents the results of comparing these two materials to help students practice Chinese. The major question that is addressed in the study relates to the effectiveness of using the two instructional materials.

In order to obtain the results, an audio tape, which developed by the Beijing Language Institute, and a computer program, which developed by the author, were used in the pilot study. The two different instructional materials were used alternately in part of a sixteen week long Introduction to Chinese course in the University of Northern Iowa. All subjects were enrolled in a five-credit, intensive elementary Chinese course during the fall semester 1991. A questionnaire that included items concerning the students' experience in learning a foreign language, and experience with Mandarin Chinese was given to all the participants. All subjects indicated that they had a few years experience in learning a foreign language but not specifically Chinese.

The textbook and the audio tape used in the class were prepared by the Beijing Language Institute. The priority was given to everyday expressions concerning clothing, food, housing, communication, entertainment, social intercourse, etc. The learners studied some information on China's culture, and history. Basic Chinese phonetics and grammar were dealt with in the Audio Lingual Approach.

The computer-based material was developed by the author using the Macintosh HyperCard program. The lessons that the author created were based on the textbook material. The priority was given to the recognition of the difference between the Chinese and English languages. The learners got the information by clicking and pointing to "buttons" on the screen. Phonetics and grammar were also dealt with by using the Audio Lingual Approach. Each lesson was supplemented with an exercise.

In order to eliminate the possibilities of unfamiliarity with the instructional tools, all subjects were taught to operate the audio tape machine and the Macintosh before the experimental phrase begun. To eliminate the draw back of difference in difficulty between each lesson, the two instructional materials were use alternately during the experimental phrase. A weekly test was used to evaluate the students' performance and the effectiveness of the two materials.

Weekly tests were developed by the Chinese instructor who came from China. Each test contained five parts. Part 1 dealt with listening comprehension. Students were asked to listen to a dialogue and answer the questions orally. Part 2 dealt with transcription. Subjects were asked to translate the Mandarin syllables into pinyin. Pinyin is an alphabetic format for writing the Chinese language. Part 3 dealt with translation. Subjects were asked to translate both English-to-Chinese and Chinese-to-English by using pinyin. Part 4 dealt with character writing. Subjects were asked to translate the English sentences into Chinese characters. Part 5 deal with tone recognition. Subjects were asked to identify both spoken and written form of Mandarin. Each part of the test was worth 20 points, with a total of 100 points for test. Thirteen tests were given to the subjects for the entire course, however, only eight of the tests were used within this study.

Because of the experimental phrase began at the eighth week of the course, the comparison of the two instructional tools focused on the skills associated with the final eight weeks. Subjects' performance on each part of the test were reported to the author weekly. The mean score of each subject was compared to the others to find out the difference between treatments.

The results illustrated that students performed better in the weeks in which computer-based materials were used. The results also indicated that in some skill areas, the two instructional tools did not show a noticeable difference in helping subjects to learn Chinese. For example, in the listening comprehension part, the performance of the subjects did not show an obvious difference when compared. Results also indicated that subjects performed the best on the translation part while they were using the CBI material. It may have been because subjects had the chance to actively practice their reading, writing, and recognizing skills directly from the CBI materials. In the character writing part, results showed that students' performance was better on the weeks in which CBI was used. Also, according to the subjects' self-evaluation, the CBI was rated higher than the audio tape in delivering the lessons. Subjects also reported that they needed less time on mastering the lessons while the CBI was used.

Although the results of the study indicated that using CBI to help practice Chinese was better than the use of audio tape, it was limited in recognition of students' utterance in order to help them practice the speaking skill. Furthermore, the study had demonstrated that it is possible to use CBI materials to teach non-alphabetical languages. It is recommenced that further study to compare the two different instructional tools is appropriate. Future studies should explore the capability of integrating many instructional methods in the development of CBI instructional material for teaching a non-alphabetic language like Chinese.

Title:

The Effects of Learner Control and Group Composition in Computer-Based Cooperative Learning

Author:

Ali Simsek

Abstract

This study examined the effects of instructional control and aptitude composition on performance, interaction, and attitudes during a computer-based cooperative science lesson. A sample of 152 fifth and sixth grade students completed the instruction either under the learner control (LC) or the program control (PC) treatment. In the LC treatment, students exercised control over the amount, review, and sequence of instruction. Students in the PC treatment followed a predetermined instructional path. At the end of the lesson, all students completed a posttest and an attitude questionnaire. They also indicated their confidence by predicting the score on the posttest. An identical test was administered two weeks later for measuring retention. Time for each group and interaction in representative groups were also recorded. Results suggested that both heterogeneous grouping and learner control had significant effects on learning, time on task, verbal interaction, and attitudes. Working in heterogeneous groups increased confidence more than working in homogeneous groups. High-ability students outperformed low-ability students on all dependent variables, except attitudes. The implications for designing group-based microcomputer software and future research are discussed.

The Effects of Learner Control and Group Composition in Computer-Based Cooperative Learning

It is often argued that microcomputers are capable of delivering effective instruction by adjusting the content to cognitive and affective needs of each student. This capability had considerable effects on instructional designers by encouraging, in some cases forcing, them to develop learning materials which are sensitive to individual differences of students. Efforts toward integrating the power of computers with the popularity of individualized instruction have long dominated the educational software market.

The evidence from research shows that individualized instruction may be effective under certain conditions. Using familiar contexts for learning consistently yielded better performance and attitudes (Ross & Morrison, 1989). Adapting the lesson sequence or the difficulty of practice items to individual differences promoted higher student achievement (Tennyson, 1981). Tailoring the instruction to progress and needs of each student resulted in better learning efficiency (Wang & Walberg, 1983).

However, there is also evidence showing that individualized instruction may not always be desirable. Although educators in public schools often assume that computer-based instruction must incorporate an individualistic paradigm of learning, researchers have raised serious questions regarding the effectiveness of individualized instruction (Hooper, 1992; Johnson & Johnson, 1986; Mevarech, Stern, Levita, 1987).

It appears that even the most successful form of individualized instruction may have some problems. First, the high cost and complexity of designing adaptive instruction that caters to a wide variety of learning needs may impose severe limitations on the potential for delivering individualized instruction. Practical constraints become particularly challenging when students need separate workstations for completing instruction (Hooper & Hannafin, 1991). Second, individualized instruction may reduce student experiences to the resources provided only by the learning environment. This approach denies the benefits of peer interaction which can be highly useful in many learning situations such as those involving prosocial behavior, group-to-individual transfer, and creative skills (King, 1989; Webb, 1982). Finally, working alone for extended periods may create isolated situations in which students are bored, anxious, and frustrated. These feelings may have deteriorating effects on students' achievement motivation (Johnson & Johnson, 1986).

The limitations of individualized instruction have forced educators to develop more effective strategies. Cooperative learning has been suggested as a powerful alternative to individualized instruction (Johnson & Johnson, 1989; Kagan, 1992; Sharan, 1980; Slavin, 1983). However, there are a number of cooperative learning methods. What characterizes these methods is that students work together in small groups to accomplish a common goal. Such a collaboration usually involves positive interdependence promoting mutuality among students, individual accountability as a measure of personal responsibility, peer interaction generating instructional support, social skills necessary for working effectively with others, and group processing as a way of improving team performance.

A large body of research suggests that cooperative learning methods may be more effective than competitive and individualistic experiences in promoting desired educational outcomes. For example, a meta-analysis that examined 226 studies comparing the impact of cooperative and individual structures on student performance yielded an average effect size of .63 in favor of cooperation. Similar results were reported for the comparison of cooperative and competitive methods (Johnson & Johnson, 1989). Most of these studies, however, were conducted in regular classrooms with limited use of emerging interactive technologies such as computers and videodiscs. The effectiveness of technology-based cooperative learning environments have been examined only in recent years. The results from several integrative reviews suggested that cooperative learning which incorporated new technologies improved both cognitive and affective outcomes (Rysavy & Sales, 1991; Webb, 1988).

Although it is not known what exactly mediates the effectiveness of cooperative learning, group composition is frequently mentioned as a potential factor producing better achievement and attitudes. Cooperative learning usually involves heterogeneous grouping; that is, groups are formed to include students from discrepant aptitudes, gender, social status, and ethnic backgrounds. Despite this common use, researchers are not in complete agreement on the efficacy of heterogeneous grouping.

Supporters of heterogeneous grouping claim that all students benefit from working with partners of different abilities. It is argued that high ability members of the group may take an active role in providing support and guidance to their low ability partners. These activities often involve the use of generative strategies that makes the learning experience more meaningful (Wittrock, 1990). Heterogeneous grouping may also provide beneficial opportunities for low ability students. As a consequence of receiving personalized help and academic support from more able partners in the group, low ability students may improve their personal expectations for competence and invest more effort toward accomplishing the group goal (Cohen, Lotan, Catanzarite, 1990). A number of studies demonstrated that all students benefited from working in heterogeneous groups compared to working alone (Dalton, Hannafin, & Hooper, 1989; Gabbert, Johnson, & Johnson, 1986; Hooper, 1992; Johnson, Skon, & Johnson, 1980; Simsek & Hooper, 1992; Yager, Johnson, Johnson, & Snider, 1986). There is also evidence showing that heterogeneous grouping, compared to homogeneous one, is particularly effective for less able students while it is not detrimental for their high ability partners (Hooper & Hannafin, 1991; Simsek & Tsai, 1992).

Critics of heterogeneous grouping claim that it promotes personal gains for some students at the expense of others, but these researchers are divided as to who benefits most from heterogeneous group work. After reviewing some studies, Hill (1982) concluded that the achievement of high ability students was hindered by medium and low ability partners. Beane and Lemke (1972), on the other hand, found that heterogeneous grouping helped high ability students more than did other members of the group. Similar questions were raised for the achievement of low ability students. Slavin (1983) argued that heterogeneous grouping may offer few opportunities for low ability students when they are simply given the correct answers without explaining the solution process behind answers. Peterson and Janicki (1979) supported that high ability students performed better and had more positive attitudes in small groups, whereas low ability students gained more from traditional whole class instruction. Goldman (1965) provided contrasting evidence indicating that students working with partners of higher abilities performed better than those working with partners of similar or lower abilities. Researchers also suggested that average students are often neglected in heterogeneous groups. Swing and Peterson (1982) found that peer interaction in mixed groups facilitated the achievement of high and low ability students, but did not affect the achievement of medium ability students. Webb (1982) reported similar findings suggesting that average students in homogeneous groups showed better achievement and received more explanations than average students in heterogeneous groups. It appears that even the critics of heterogeneous ability grouping agree on the effectiveness of cooperation in small groups, but they do not have a clear consensus as to what types of students benefit most from this experience.

The inconclusiveness of research findings on cooperative group composition forces educators to develop better intervention strategies that will enhance the performance of all students working in small groups. One strategy for providing more effective instruction is to give students an opportunity to have control over their own learning. Exercising control based upon group decisions may help students develop better metacognitive skills needed for successful learning.

The concept of learner control is intuitively appealing because students differ in aptitudes, interests, motivation, learning styles, and personality variables (Carrier, 1984). The results from a number of experimental studies suggest that there are certain situations in which exercising control is more effective than following a fixed instructional sequence. When students were allowed to adjust the familiarity of content to their own backgrounds, for example, they performed significantly better on both achievement and attitude measures (Ross, 1984). Similarly, providing students with advice about their academic performance and learning needs has been found to be more effective than imposing a fixed instructional sequence or complete learner control (Tennyson & Rothen, 1979). Researchers argue that guided learner control that is contingent upon students' ongoing performance combines the most desirable features of adaptive instructional support and personal decision making.

Studies also demonstrate that practicing control does not always promote desired educational outcomes. Given total learner control, students usually terminate the lesson prematurely or they cannot make appropriate decisions regarding the instruction they need to complete (Carrier, 1984; Kinzie, 1990; Snow, 1980; Tennyson, 1981). It has been suggested that particularly younger and less able students benefit very little from exercising control, compared to mature and more able students (Hannafin, 1984; Steinberg, 1989). An explanation for these results may be that low ability students usually lack metacognitive skills that are critical in evaluating the situation and producing effective solutions. Having failed frequently on academic tasks, these students may be more comfortable with external instructional support (Simsek & Sales, 1992).

Although there seems to be a strong agreement in the literature, only several studies examined the relationship between student ability and instructional control. Ross and Rakow (1981) conducted a study in which the number of supporting examples was adapted to pretest scores through program control, selected through learner control, kept constant, or nonadaptive content was presented through traditional lecture. Results demonstrated that program control of instructional support promoted highest mathematics achievement on both immediate and delayed posttests while learner control resulted in lowest achievement. Nonadaptive support and traditional lecture treatments produced medium-range outcomes. The results also suggested that program control was more effective for low ability students. Fry (1972) found similar findings indicating that high ability students learned significantly more under a high degree of learner control. Gay (1986) reported that students with higher prior knowledge performed equally well under both program control and learner control treatments, but students with low prior understanding scored less under learner control as a result of poor sequencing decisions. It is important to note that all of these studies were conducted in college environments with relatively mature participants. Results appear to be different with younger students. For example, Klein and Keller (1990) found that type of instructional control did not affect performance and confidence of seventh grade students, whereas ability and locus of control improved the same outcomes. More research needs to be conducted in elementary classrooms for obtaining conclusive results.

It is also true that most of the conclusions about learner control have been derived from studies on individualized instruction. The effects of exercising learner control in cooperative groups are not known yet. It is crucial for instructional designers to recognize that research findings from individualized instruction may not necessarily be generalizable to small group learning. When high ability students dominate the group, for example, low ability students may suffer from completing too little or difficult instruction. When less able students dominate, on the other hand, more able students may suffer from completing too much instruction or being bored (Simsek & Hooper, 1992).

The basic question still remains: What will be the effects of exercising control on performance, interaction, and attitudes of students working together in homogeneous and heterogeneous ability groups during a computer-based cooperative science lesson? Further research is needed to answer this question. The purpose of the present study is to extend research findings by determining whether exercising control over the amount, sequence, and review of instruction in cooperative groups would be more effective than following a fixed instructional path.

Method

Subjects

A sample of 152 fifth and sixth grade students from a suburban school district in Minnesota participated in the study. Of this total number, 84 (55%) were fifth graders and 68 (45%) were sixth graders. The gender distribution was 73 (48%) males and 79 (52%) females. The sample comprised primarily of middle-class, Anglo-American students with a small percentage of other ethnic backgrounds. Approximately equal number of subjects were randomly assigned to treatment conditions.

Materials

Lesson Content. Students completed a tutorial lesson on solar energy. The CBI lesson was originally developed by Kinzie, Sullivan, and Berdel (1988) for individualized instruction. Modified versions of the lesson for both individuals and cooperative groups were prepared and validated in another study (Simsek & Sales, 1992). Based upon the results of these studies and according to design principles described by Dick and Carey (1985), a formative evaluation procedure was conducted. Final version of the computer lesson contained five major segments: (a) solar power; (b) active solar heating; (c) passive solar heating; (d) solar cells; (e) future of solar energy. In addition to these instructional segments, the lesson included an introduction explaining the rules of cooperation and a closing with comments about the performance of students. Relative to the control strategy embedded in the lesson, students received instruction that varied by amount, review, and sequence.

Ability Test. Students were classified as high and low ability according to their performance on the Iowa Test of Basic Skills. Students with combined scores at or above the 60th percentile were defined as high ability, while low ability students were defined as those with the combined scores at or below the 40th percentile. As a way of reducing the classification error, students with combined scores between the 60th and 40th percentiles were not included in the study. The KR-20 reliability for this standardized ability test for both 5th and 6th grade students was .91.

Posttest. Students completed an individual posttest both at the end of the instruction and approximately two weeks after the instruction. The test included 40 multiple-choice questions. Half of the questions consisted of recall items whereas the other half contained comprehension items. The KR-20 reliability for this posttest was .83 with an average item difficulty of .67. A typical recall item on the test was: "What is the basic source of energy that all living creatures use? (a) Sunshine; (b) Electricity; (c) Gasoline; (d) Fossil fuels". A typical comprehension item was: "Which of the following is more likely in the twenty-first century? (a) Fossil fuels will no longer be used; (b) Solar energy will be the alternative to nuclear power; (c) Most of the old buildings will be using passive solar heating; (d) Water will be the main source of energy".

Attitude Questionnaire. Following the immediate posttest, students responded to a Likert-type questionnaire. This instrument contained 30 items, divided equally among the categories of attitudes toward the delivery system, subject matter, and team work. Possible responses ranged from "Strongly Agree (5)" to "Strongly Disagree (1)". The Cronbach's Coefficient Alpha reliability for the questionnaire was .91. A typical item for each category was: "I enjoyed working with the computer" (delivery system); "I would like to learn more about solar energy" (subject matter); and "I feel more comfortable working in a small group than working alone" (team work).

Interaction Scale. Peer interaction in twenty representative groups was videotaped and analyzed according to categories of the Interaction Scale. This scale contained ten categories: (a) reading information; (b) asking questions; (c) giving answers; (d) seeking clarification; (e) providing explanations; (f) making comments; (g) energizing the group; (h) suggesting directions; (i) entering group response; (j) demonstrating off-task behavior. The coding of peer interaction in groups was performed by two well-trained observers who had expertise on cooperative learning and computer-based instruction. Several videotapes were coded by both observers for calculating reliability. Analysis of group interaction also included qualitative data regarding the nature and degree of student discourse.

Training Observers

Two observers were trained about analyzing interaction in small groups. Training comprised of several stages. First, the experimental procedures were explained and each of the categories in the Interaction Scale was discussed. Second, the observers watched a videotape that showed two students working together on the same computer. This activity allowed the observers to pay close attention to behaviors involving group work and discuss them in detail. Third, the observers coded peer interaction in a sample group by using the Interaction Scale described above. Finally, independent codings of the two observers were compared. The percentage of agreements between the observers was .98.

Cooperative Skills Training

Students in the participating school had been trained extensively about collaborative skills. Cooperative learning is considered to be an integral part of the school curriculum. In addition to previous training, all possible subjects attended a one-hour training program designed specifically for them. The main purpose behind this activity was to encourage students to employ specific strategies involved in this study. Participants completed several exercises emphasizing the basic principles of cooperative learning.

The first exercise, called "Magic Triangle" (Johnson, Johnson, & Holubec, 1991), required students to find the maximum number of embedded triangles in a big one. Half of the participants completed this exercise in cooperative groups, while the other half worked alone. The result was overwhelmingly better success rate for those working in groups. Therefore, successful students shared their answers with all participants and explained the strategies they employed. This helped students to draw the conclusion that working with others can be more effective and enjoyable than working individually. Following this activity, the discussion focused on specific behaviors which were helpful (i.e. explaining) and not helpful (i.e. teasing) for group success.

Second, the "Broken Circles" exercise (Cohen, 1986) emphasized the importance of positive interdependence among members of a cooperative group. Each group was given pieces of broken circles. The task was to form at least one complete circle for each member. Once everyone in the group had a complete circle, members were to shuffle their pieces and form new circles. They had to exchange the pieces voluntarily without being asked for. Students were also instructed not to talk and take others' pieces unless offered. This game encouraged students to share their resources in accomplishing the mutual goal.

The third exercise, called "Contractions and Punctuations" (Johnson, Johnson, & Holubec, 1991), was about correcting grammar errors in a letter. It provided students with opportunities to practice cooperative skills on a school-related task. After this activity and presentations of several students demonstrating correct answers, participants were asked to discuss how well their group did as a team and list three advantages and disadvantages of working together with others in a small group.

Procedures

Based upon their combined scores on a standardized ability test, students were randomly assigned to homogeneous and heterogeneous groups. A homogeneous group included two students of the same ability, while a heterogeneous group included one high and one low ability student. Prior to the experiment, all students who obtained parental consent participated in the training program.

Students completed the instruction in three consecutive days, approximately thirty minutes a day. To secure confidentiality, each subject was assigned a code number. They were also given a card showing their computer number. During the first day, students completed two instructional segments. At the end of the daily session, they discussed how well their group did and listed two behaviors that were helpful and not helpful for their success. They also specified a behavior which they promised to improve for the next day. Students began the second day by discussing the important rules of cooperation as well as the information they learned from the first day. Then, they studied two additional segments of the lesson. The second day ended with similar group processing activities. Students completed the last instructional segment in the third day. Following a brief wrap-up time, the immediate posttest and attitude questionnaire were administered. Two weeks later, an identical posttest was given to measure retention.

Treatments

During the instruction, students completed either the learner control or program control version of the computer lesson. Each instructional treatment varied by the type and degree of control provided. Major differences between the two versions of the lesson are described below.

Learner Control. This treatment allowed students to exercise control over the amount, review, and sequence of instruction. Following the introduction, group members selected a segment from the main menu. They had complete control over the segment they wanted to start with. After reading and discussing the information in each lesson segment, students responded to embedded questions. They had an option of deciding the number of practice items they wanted to see. Before they answered any question, the computer told them how many items (ranging from 4 to 7) were available in that particular segment. The whole lesson contained total of 25 practice items. Because this was a cooperative lesson, group members had to carefully examine the options and reach a consensus before entering a response.

Based on their answer, students received immediate feedback. When the response was correct, affirmative feedback with a statement saying "That's correct!" was presented. When their response was incorrect, however, students were presented a statement saying "Sorry. That's incorrect. Would you like to review the material before you answer the question one more time?" Then, group members either reviewed the relevant segment or responded to the same question again. Review screens contained shorter information than original screens of the tutorial. Following the third incorrect response, the correct answer with a brief explanation saying like "The correct answer is (a) because all living creatures need sunlight to grow" was displayed. After each segment, the main menu was presented. Students decided to study another segment or terminate the lesson. Once they selected a segment, they could not exit until the practice items. At the end of the instruction, students received an evaluative comment about their overall performance.

Program Control. This treatment did not allow students to exercise control. All students completing this version of the lesson received identical instruction. Students did not make fundamental decisions or choices about the instructional sequence. They simply read the information and answered all embedded questions. Similar to the learner control treatment, students had to carefully examine the options and reach a group consensus about their response.

When the answer to a question was correct, students received affirmative feedback saying "That's correct!" and proceeded to the next question. When incorrect, on the other hand, a review of the relevant segment was automatically presented following a statement saying "That's incorrect. Let's review the material before you answer the question again". Then, students responded to the question one more time. After three incorrect responses, the correct answer with a brief explanation was presented. Upon completion of all lesson segments, students received an evaluative comment about their overall performance.

Design and Data Analysis

The study employed a 2 X 2 X 2 randomized block design. The first factor was Grouping (homogeneous, heterogeneous), the second Ability (high, low), and the third Control (learner, program). Dependent variables were achievement, confidence, retention, attitudes, time on task, and interaction. In analyzing research data, three-way ANOVA and Scheffe's multiple comparisons test were used. The alpha level for testing differences was set as .05, unless otherwise indicated.

Results

Achievement

The first dependent variable of the study was student achievement. This variable was operationalized as the individual score on the immediate posttest. Means and standard deviations for achievement scores are given in Table 1. The mean score for heterogeneous groups (M=28.37) was higher than the mean score for homogeneous groups (M=25.39). High ability students had a greater mean score than low ability students (M=29.73 and M=24.01, respectively). The mean achievement score for students who worked under the learner control treatment (M=27.73) was higher than the mean achievement score for those working under program control (M=25.99).

Insert Table 1 About Here

Three-way ANOVA results demonstrated that heterogeneous grouping significantly improved achievement compared to homogeneous grouping [F(1,144) =10.85, p<.001]. High ability students outscored low ability students [F(1,144) =41.78, p<.001]. Groups working under learner control performed better than those working under program control [F(1,144) =4.71, p<.032]. Two-way interaction effect between Grouping and Ability was significant [F(1,144) =4.85, p<.029]. The Scheffe procedure indicated that homogeneous low ability groups showed the lowest achievement compared to homogeneous high ability groups (p<.001) as well as both high (p<.001) and low ability students working together in heterogeneous groups (p<.002). The difference between the achievements high and low ability members of heterogeneous groups also showed significance (p<.035). None of the other comparisons were significant.

We also examined the effects of independent variables on recall and comprehension items separately. Results regarding comprehension items suggested similarity with the results for overall test scores. However, the results on recall items differed from the results on comprehension items in two important ways. First, the interaction between Grouping and Ability was not significant [F(1,144)=1.51, p<.221]. Instead, the interaction between Grouping and Control showed significance [F(1,144)=4.30, p<.040]. Secondly, three-way interaction was significant [F(1,144)=5.18, p<.024]. Further analyses indicated that the most obvious difference was between the achievements of low ability students working under learner control (p<.001) in homogeneous (M=10.50) and heterogeneous cooperative groups (M=14.94), suggesting the effectiveness of heterogeneity.

Confidence

The concept of confidence in this study was defined as the perceived likelihood of personal success (Keller, 1983). Upon completion of the immediate posttest, students were asked to predict their achievement score and write it down to the first page of the test. Means and standard deviations for confidence scores are presented in Table 2. Students in heterogeneous groups had higher scores than those in homogeneous groups (M=31.50 and M=28.08, respectively). High ability students (M=31.20) reported greater confidence than low ability students (M=28.33). The mean confidence score for students exercising control over the lesson was slightly higher than the mean score for those following a predetermined instructional path (M=30.07 and M=29.44, respectively).

Insert Table 2 About Here

Three-way ANOVA results yielded significant main effects for both Grouping [F(1,144)=12.38, p<.001] and Ability [F(1,144)= 9.05, p<.003]. Heterogeneous groups and high ability students outscored homogeneous groups and low ability students. Neither the main effect for Control [F(1,144) =0.52, p<.470] nor the interactions were significant.

Retention

In order to measure retention, an identical posttest was administered two weeks after the instruction. Data from 145 students were included in the analysis since 7 students were absent during the retention test. The correlation between scores on the immediate and the retention posttests was .73. Means and standard deviations for retention scores are contained in Table 3. Students in heterogeneous groups (M=26.51) had higher retention scores than those in homogeneous groups (M=24.16). The mean score for high ability students was higher than the mean score for low ability students ((M=28.44 and M=22.18, respectively). Students working under learner control (M=26.47) had higher retention scores than those working under program control (M=24.01).

Insert Table 3 About Here

Three-way ANOVA results demonstrated that heterogeneous groups retained more information than homogeneous groups [F(1,137)=5.07, p<.026]. High ability students consistently outperformed low ability students on the retention posttest [F(1,137)=40.65, p<.001]. Exercising learner control was more effective for retention than following a fixed instructional sequence [F(1,137)=6.79, p<.010]. None of the interactions was significant.

Attitudes

Another dependent variable was attitudes toward the delivery system (CBI), subject matter (science), and group work (pairs). Means and standard deviations for total attitude scores are included in Table 4. Students in heterogeneous groups had a higher mean score than those in homogeneous groups (M=119.95 and M=113.49, respectively). The mean score for low ability students (M=117.56) was greater than the mean score for high ability students (M=115.68). Students working under learner control had a higher mean attitude score than those working under program control (M=120.19 and M=113.26, respectively).

Insert Table 4 About Here

Three-way ANOVA results suggested the effectiveness of heterogeneous groups because the main effect for Grouping was significant [F(1,144)=5.70, p<.018]. Although there was a difference in the attitudes of high and low ability students, the main effect for Ability was not significant [F(1,144)=0.57, p<.452]. The main effect for Control was significant [F(1,144)=6.89, p<.010] in favor of learner control. Among interactions, only the interaction between Grouping and Ability was significant [F(1,144)=5.00, p<.027]. The Scheffe procedure indicated a statistically significant difference between the attitudes of low ability students in homogeneous and heterogeneous groups (p<.015).

We also checked the significance of results according to categories of the attitude questionnaire. On the subscale for attitudes toward computer-based instruction, only the main effect for Grouping [F(1,144)=5.49, p<.020] and interaction between Grouping and

Ability were statistically significant [*F*(1,144)=4.09, *p*<.045]. The Scheffe procedure showed significance between the attitudes of low ability students in homogeneous and heterogeneous groups favoring heterogeneity (*p*<.025). No comparison was statistically significant on the subscale for attitudes toward science. On the subcategory for attitudes toward group work, the main affect for Grouping was significant [*F*(1,144)=4.27, *p*<.041]. This suggested that students in heterogeneous groups developed more positive attitudes toward group work. The main effect for Ability was not statistically significant [*F*(1,144)=0.24, *p*<.627]. Learner control promoted better attitudes toward working with others in groups than program control [*F*(1,144)=14.17, *p*<.001]. Two-way interaction between Grouping and Ability was the only significant interaction effect [*F*(1,144)=6.78, *p*<.010]. The Scheffe procedure showed significant differences between the attitudes of low ability students in homogeneous and heterogeneous learning groups (*p*<.010) favoring heterogeneity. No other comparison was statistically significant.

Time on Task

Amount of time for each cooperative group was recorded during the instruction. The means and standard deviations for time on task are mentioned in Table 5. The average time for homogeneous groups (M=62.46) was longer than average time for heterogeneous groups (M=57.89). High ability students (M=58.88) spent less instructional time than low ability students (M=61.56). The completion time was shorter for students who exercised control (M=57.32) than those who followed a predetermined instructional path (M=63.00).

Insert Table 5 About Here

Three-way ANOVA results indicated that homogeneous groups used significantly longer time than heterogeneous groups [*F*(1,144)=14.27, *p*<.001]. High ability students spent less time on task than low ability students [*F*(1,144)=4.68, *p*<.032]. Program control required more time to complete the lesson than learner control [*F*(1,144)=22.60,

$p<.001$]. Two-way interaction effect between Grouping and Ability was also significant [$F(1,144)=4.68$, $p<.032$]. The Scheffe procedure suggested efficiency for homogeneous high ability groups ($p<.025$) and students in heterogeneous teams compared to low ability students in homogeneous groups. No other comparison suggested statistically significant differences regarding time on task.

Interaction

Peer interaction in groups was coded according to ten categories of the Interaction Scale, but only eight of these categories were related to verbal interaction among students. The other two categories were "entering group response" and "demonstrating off-task behavior". They were excluded from comparisons of the treatment groups because these behaviors sometimes did not involve peer interaction or group behavior that were directed to completion of the task. The means and standard deviations for total verbal interaction are reported in Table 6. The mean score for heterogeneous groups (M=132.31) was higher than the mean score for homogeneous groups (M=100.17). High ability students averaged a greater verbal interaction score than low ability students (M=134.60 and M=91.45, respectively). The mean score for students working under the learner control treatment (M=132.30) was higher than the mean score for those working under the program control condition (M=93.75).

Insert Table 6 About Here

Three-way ANOVA yielded a significant main effect in favor of heterogeneous grouping [$F(1,32)=4.44$, $p<.043$]. The difference between the interaction means of high and low ability students was significant [$F(1,32)=6.70$, $p<.014$]. Students working under learner control engaged in more verbal interaction than those working under the program control treatment [$F(1,32)=5.46$, $p<.026$]. None of the interaction effects was statistically significant. We also checked the predictability of student achievement based on interaction categories. The means, standard deviations, and correlations of interaction categories with achievement are presented in Table 7.

Insert Table 7 About Here

It appears that only three categories of peer interaction can successfully predict student achievement. Those are seeking clarifications from the partner ($r=.315$, $p<.047$), providing explanations after giving an answer ($r=483$, $p<.002$), and demonstrating off-task behavior during the group work ($r=-445$, $p<.004$). It should be noted, however, that the correlation between off-task behaviors and student achievement was a negative one. When total verbal interaction scores are used to predict achievement on the posttest, the correlation was positive and significant ($r=349$, $p<.027$).

Discussion

This study investigated the effects of exercising control over the amount, review, and sequence of instruction in mixed and uniform ability groups during a computer-based cooperative lesson on solar energy. Dependent variables included achievement, confidence, retention, attitudes, time on task, and interaction.

Students in heterogeneous cooperative groups outperformed their counterparts in homogeneous groups. The achievement differences were particularly noticeable when low ability students in homogeneous groups were compared with others including low ability members of heterogeneous teams. It appears that interaction among students of discrepant abilities provides beneficial opportunities for low ability students, and it is not detrimental for the achievement of high ability students. This result is consistent with the established findings of research on cooperative group composition (Hooper & Hannafin, 1991; Simsek & Tsai, 1992). A possible interpretation of this result is that low ability students receive peer encouragement and personalized support from their more able partners. They perceive that their contributions are expected and valued for success of the group. Their partners are available to help them when they need a customized explanation for finding the answer or figuring out the solution process. When they have an incorrect idea, more able students in the group can explain why that answer is not acceptable. When the group contains all low ability students, on the other hand, members usually share the mistakes. After getting the feedback from the computer, they realize that their response is not an acceptable one. They try to enter another response without developing an alternative solution proposal because low ability students are usually unable to do so. By continuing this simple tryout pattern, group members start loosing their motivation and the perception that their partner is able to help or offer different views.

Ability was an important factor in achievement. High ability students performed significantly better than low ability students. Based on a large body of research, this is not a surprising result (Johnson & Johnson, 1989). The critical point is that high ability members of cooperative groups are usually more active in group discussions contributing toward their own success and the success of their partners. These students also perform a leadership role in heterogeneous groups by providing personalized explanations and clear directions to their low ability groupmates. All these activities involve deeper information processing and metacognitive skills including generative activities which seem to contribute to the achievement of more able students.

Students working under learner control outperformed their counterparts working under program control. This result is somewhat contrary to the conclusions derived from studies on individualized instruction because there is a tendency in the literature suggesting that elementary students cannot make appropriate decisions about their own learning needs (Carrier, 1984; Hannafin, 1984; Steinberg, 1989). It seems reasonable to expect that when students do not have metacognitive skills necessary for effective decision making, they will not be able to benefit from exercising control compared to following a fixed instructional sequence embedded in the computer lesson. However, the present study suggested that this explanation may not be applicable to cooperative learning since group members usually discuss the options carefully before making a decision or choice. When the lesson requires a group consensus about each response, many mistakes can be avoided as a consequence of getting another opinion. This is not to say that all students will be good decision makers in cooperative groups. A careful attention should be given to heterogeneity of the group and mastery contingencies for all students. Providing learner control option can be harmful or ineffective for the achievement of low ability students working in homogeneous groups. The results of this study concerning performance on recall items suggested that low ability students in homogeneous groups did not benefit from practicing control. Each decision was a challenge for these students. However, it was not the case for low ability students in heterogeneous groups because each decision served as an opportunity generating further discussion and learning from partners. It was suggested that such a situation may motivate group members to engage in more discussion that results in providing elaborative feedback (Carrier & Sales, 1987).

Results of the study suggested that heterogeneous grouping significantly improved student confidence about performance on the posttest. Also, high ability students were more confident than low ability students. However, exercising control over the instruction did not affect confidence. These results provide partial support for the findings of several other studies suggesting that student ability and cooperation in heterogeneous small groups increase confidence, while type of instructional control does not have a significant influence on the outcomes (Klein & Keller, 1990; Simsek & Sales, 1992). It may be that low ability students cooperating with equals in homogeneous groups do not have confidence either in themselves or their partners. Similarly, high ability students in homogeneous groups may lack the opportunity for comparing themselves with others because they do not receive ideas or solution proposals which are neither above nor below their own level of cognitive complexity. In heterogeneous groups, however, students can compare their performance with the performance of their partners. High ability members of the group may feel good about themselves because they know more about the task and can provide others with help to improve their performance. Low ability students in heterogeneous group may perceive that they are contributing toward the mutual goal with the support and encouragement of more able partners. Such a perception may increase their expectations for competence and motivate them to invest more efforts directed toward group goals (Cohen, 1986). Type of instructional control may not be a strong determinant in this process characterized mostly by group dynamics rather than whether the control option is given or not.

Retention results suggested that heterogeneous grouping was more effective than homogeneous grouping to help students retain more information. A possible explanation might be that members of heterogeneous groups benefit from a variety of alternatives and explanations offered to solve a problem or answer a question. When different explanations are provided, students restructure their own rationale and enrich their cognitive reasoning. Some these strategies may help them find clever ways of remembering or comprehending facts which were the core of the learning program used in the present study. This may also explain that high ability students performed better on the retention posttest than low ability students. Learner control option along with the requirement of reaching group consensus before entering each response might have provided additional opportunities for engaging in further and elaborated discussion promoting a higher retention rate than the program control treatment.

Students in heterogeneous groups developed more positive attitudes than those in homogeneous groups. Low ability students in homogeneous groups reported the lowest attitude scores than the other treatment groups. The difference in overall attitudes was particularly obvious when low ability students in homogeneous groups were compared with their low ability counterparts in heterogeneous groups. Moreover, this positive effect in favor of heterogeneity was not due to an accompanying decrement in the attitudes of high ability students cooperating with low ability students. These findings are consistent with the results of many other research studies (Dalton, Hannafin, & Hooper, 1989; Johnson & Johnson, 1989; Sharan, 1980; Simsek & Tsai, 1992). It may be that low ability students in heterogeneous groups feel more supported and satisfied than those in other groups as a consequence of their interaction with more able partners. This may produce a friendly and motivating environment in which students like the computer and cooperative group work better, but these feelings or perceptions may not be strong enough to have direct influences on the subject matter.

Ability did not affect attitudes. Perhaps, affective outcomes as operationalized in this study cannot easily be influenced by aptitude variables. Another possibility is that attitudes toward the delivery system, subject matter, and group work are mostly situational and may not be positively correlated with student ability. Also, the interaction between Grouping and Ability in favor of low ability members of heterogeneous groups may have reduced the possibility for finding a significant main effect for ability.

Students exercising control over the lesson developed more positive attitudes than those following a predetermined instructional path. This result is supportive of the findings reported by Simsek and Sales (1992). Students exercising control over the lesson may feel that they have certain amount of freedom, choice, and flexibility in the learning process. They may also think that they are the ones making important decisions and their decisions are respected. Given an option to decide whether to receive more instruction, skip certain parts of the lesson, or terminate the instruction may create intrinsic motivation and promote more positive attitudes toward components of that particular learning environment (Carrier & Sales, 1987; Kinzie, 1990; Steinberg, 1989).

Results regarding time on task demonstrated that heterogeneous groups and learner control subjects used significantly less instructional time than homogeneous groups and program control subjects. The main effect for Ability was also significant. Analysis of the interaction between Grouping and Ability showed that low ability students in homogeneous groups consistently needed more time to complete the lesson than the other groups. These results support the efficiency of cooperative learning for less able students in heterogeneous groups (Hooper & Hannafin, 1991; Simsek & Hooper, 1992; Simsek & Tsai, 1992; Webb

& Cullian, 1983). The reason might be that students in heterogeneous groups develop higher understanding of the task and employ more effective strategies in accomplishing the mutual goals. As a consequence of interacting with more able partners, low ability students in heterogeneous groups may acquire better problem solving skills. Using more efficient strategies may save important amount of time for these students. Low ability students in homogeneous groups, however, may not benefit from diversity in generating solutions that help them avoid typical mistakes and time consumption. The efficiency of learner control may be attributed to exercising control over the amount of instruction as well as using the review option effectively.

The interaction results are in agreement with the findings of other relevant studies (Hooper, 1992; King, 1989; Webb, 1983). When peer interaction in groups was analyzed based on certain categories of interaction behaviors, providing elaborations after giving an answer was found to be a successful predictor of student achievement. Another category which seem to be a good predictor of achievement was seeking clarification after receiving an answer or explanation from the partner. The correlations between these two categories and achievement were both positive and statistically significant. The final category which had the potential to predict achievement successfully was demonstrating off-task behavior during the group work. However, the correlation between this category and achievement was a negative one. That is, any increase in off-task behavior accompanied a decrease in achievement scores on the posttest.

When the categories related to verbal interaction among students were combined and the significance of differences among treatment groups were compared, all independent variables showed significant main effects, suggesting the effectiveness of heterogeneous grouping, higher ability, and learner control. It is reasonable to expect that when students are to make selections or decisions, they engage in more interactions compared to those following a fixed sequence of instruction. It is also reasonable to assume that members of heterogeneous groups demonstrate greater exchange of ideas as a consequence of trying to convince their partners with diverse abilities. Students in homogeneous groups, however, may have more agreements than disagreements as a result of their similarities. This makes discussions or explanations unnecessary, but students benefit from explaining even in the case agreement with their partners because explanations may clarify misunderstandings as well as potential conflicts.

The results of this study have certain implications for both instructional designers and educational researchers. It appears that heterogeneous cooperative grouping is an effective, appealing, efficient alternative to individualized instruction. This kind of learning particularly benefits low ability students, and it is not detrimental for high ability students. Most of the problems associated with learner control can be overcomed when members of heterogeneous groups make the decisions together. Diversity among these students can be a motivating factor when students seek and provide explanations. It seems likely that high ability students will dominate group interaction, but a knowledgeable instructional designer can incorporate certain elements providing equal opportunities for participation of all group members. Such important features of computer-based instructional lessons may include requiring a consensus for each response, encouraging students to explain their rationales behind decisions, assigning critical roles to members, checking randomly if everyone has agreed on the choices made, giving multiple opportunities for mastery before proceeding to the next practice item or lesson segment, asking students to take turns using input devices, and providing specific instructions for effective group processing.

Further research is needed to clarify the relationship between group composition with regard to students' learning styles and academic performance. Integrating generative activities into cooperative decision making should be further investigated. The effects of various feedback strategies during cooperative group work needs to be examined. The relationship between exercising learner control and manipulating group size deserves more research attention. Qualitative studies may provide better insights than quantitative studies in analyzing peer interaction in cooperative groups.

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Table 1. Means and Standard Deviations for Achievement Scores

Ability	Learner	Program	Total
		Type of control	
		Homogeneous	
High			
M:	30.78	27.85	29.24
SD:	4.52	5.63	5.28
N:	18	20	38
Low			
M:	21.15	22.30	21.73
SD:	5.82	6.11	5.92
N:	20	20	40
Total			
M:	25.71	25.08	25.39
SD:	7.11	6.44	6.74
N:	38	40	78
		Heterogeneous	
High			
M:	31.28	29.26	30.24
SD:	4.94	5.45	5.24
N:	18	19	37
Low			
M:	28.44	24.63	26.49
SD:	3.71	6.25	5.46
N:	18	19	37
Total			
M:	29.86	26.95	28.37
SD:	4.54	6.24	5.64
N:	36	38	74
		Combined	
High			
M:	31.03	28.54	29.73
SD:	4.68	5.52	5.25
N:	36	39	75
Low			
M:	24.61	23.44	24.01
SD:	6.11	6.21	6.15
N:	38	39	77
Total			
M:	27.73	25.99	26.84
SD:	6.31	6.37	6.38
N:	74	78	152

Table 2. Means and Standard Deviations for Confidence Scores

	Type of control		
Ability	Learner	Program	Total
		Homogeneous	
High			
M:	30.72	28.65	29.63
SD:	4.04	5.33	4.82
N:	18	20	38
Low			
M:	26.45	26.75	26.60
SD:	8.00	7.25	7.54
N:	20	20	40
Total			
M:	28.47	27.70	28.08
SD:	6.71	6.36	6.50
N:	38	40	78
		Heterogeneous	
High			
M:	33.06	32.58	32.81
SD:	3.92	4.56	4.21
N:	18	19	37
Low			
M:	30.44	29.95	30.19
SD:	7.61	3.78	5.88
N:	18	19	37
Total			
M:	31.75	31.26	31.50
SD:	6.11	4.34	5.25
N:	36	38	74
		Combined	
High			
M:	31.89	30.56	31.20
SD:	4.10	5.30	4.77
N:	36	39	75
Low			
M:	28.34	28.31	28.33
SD:	7.97	5.97	6.99
N:	38	39	77
Total			
M:	30.07	29.44	29.74
SD:	6.59	5.72	6.15
N:	74	78	152

Table 3. Means and Standard Deviations for Retention Scores

	Type of control		
Ability	Learner	Program	Total
		Homogeneous	
High			
M:	29.94	27.22	28.08
SD:	6.84	5.56	6.20
N:	18	18	36
Low			
M:	20.75	20.50	20.63
SD:	5.46	6.45	5.90
N:	20	20	40
Total			
M:	24.63	23.68	24.16
SD:	7.35	6.87	7.08
N:	38	38	76
		Heterogeneous	
High			
M:	31.75	26.58	28.94
SD:	6.63	6.31	6.88
N:	16	19	35
Low			
M:	25.59	22.41	24.00
SD:	3.54	6.05	5.14
N:	17	17	34
Total			
M:	28.58	24.61	26.51
SD:	6.05	6.46	6.53
N:	33	36	69
		Combined	
High			
M:	30.27	26.72	28.44
SD:	6.79	5.87	6.54
N:	34	36	70
Low			
M:	22.97	21.38	22.18
SD:	5.22	6.26	5.78
N:	37	37	74
Total			
M:	26.47	24.01	25.28
SD:	7.01	6.60	6.90
N:	71	73	145

Table 4. Means and Standard Deviations for Attitude Scores

Ability	Learner	Program	Total
		Homogeneous	
High			
M:	119.11	112.15	115.45
SD:	10.95	17.54	15.02
N:	18	20	38
Low			
M:	112.65	110.60	111.63
SD:	19.58	23.44	21.34
N:	20	20	40
Total			
M:	115.71	111.38	113.49
SD:	16.20	20.45	18.51
N:	38	40	78
		Heterogeneous	
High			
M:	120.44	111.63	115.92
SD:	10.48	15.81	14.03
N:	18	19	37
Low			
M:	129.39	118.84	123.97
SD:	11.53	17.69	15.74
N:	18	19	37
Total			
M:	124.92	115.24	119.95
SD:	11.77	16.95	15.35
N:	36	38	74
		Combined	
High			
M:	119.78	111.90	115.68
SD:	10.58	16.50	14.44
N:	36	39	75
Low			
M:	120.58	114.62	117.56
SD:	18.16	20.99	19.74
N:	38	39	77
Total			
M:	120.19	113.26	116.63
SD:	14.86	18.81	17.30
N:	74	78	152

Table 5. Means and Standard Deviations for Instructional Time

	Type of control		
Ability	Learner	Program	Total
		Homogeneous	
High			
M:	58.11	61.40	59.84
SD:	9.68	5.86	7.97
N:	18	20	38
Low			
M:	60.60	69.30	64.95
SD:	8.83	5.83	8.60
N:	20	20	40
Total			
M:	59.42	65.35	62.46
SD:	9.20	7.02	8.63
N:	38	40	78
		Heterogeneous	
High			
M:	55.11	60.53	57.89
SD:	6.72	7.37	7.49
N:	18	19	37
Low			
M:	55.11	60.53	57.89
SD:	6.72	6.72	7.49
N:	18	19	37
Total			
M:	55.11	60.53	57.89
SD:	6.62	7.27	7.44
N:	36	38	74
		Combined	
High			
M:	56.61	60.97	58.88
SD:	8.35	6.57	7.74
N:	36	39	75
Low			
M:	58.00	65.03	61.56
SD:	8.28	7.90	8.78
N:	38	39	77
Total			
M:	57.32	63.00	60.24
SD:	8.29	7.50	8.37
N:	74	78	152

Table 6. Means and Standard Deviations for Verbal Interaction

Ability		Type of control		
		Learner	Program	Total
			Homogeneous	
High	M:	163.00	95.17	129.08
	SD:	57.98	37.11	58.39
	N:	6	6	12
Low	M:	87.50	55.00	71.25
	SD:	63.65	19.95	48.07
	N:	6	6	12
Total	M:	125.25	75.08	100.17
	SD:	70.18	35.31	60.07
	N:	12	12	24
			Heterogeneous	
High	M:	160.25	125.50	142.88
	SD:	51.91	40.01	46.75
	N:	4	4	8
Low	M:	125.50	118.00	121.75
	SD:	46.60	45.28	42.72
	N:	4	4	8
Total	M:	142.88	121.75	132.31
	SD:	49.30	39.76	44.62
	N:	8	8	16
			Combined	
High	M:	161.90	107.30	134.60
	SD:	52.61	39.29	53.17
	N:	10	10	20
Low	M:	102.70	80.20	91.45
	SD:	57.97	44.30	51.52
	N:	10	10	20
Total	M:	132.30	93.75	113.03
	SD:	61.85	43.06	56.11
	N:	20	20	40

Table 7. Means, Standard Deviations, Correlations with Achievement, and Probabilities of Interaction Categories

Category	M	SD	r	p
Reading information	26.38	19.13	.275	.085
Asking questions	10.55	6.38	.178	.273
Giving answers	30.95	15.35	.220	.173
Seeking clarification	2.68	2.98	.315	.047
Providing explanations	15.33	15.14	.483	.002
Making comments	5.60	4.19	-.099	.542
Energizing the group	13.93	11.48	.224	.164
Suggesting directions	7.58	5.38	-.120	.462
Entering group response	36.80	23.89	.227	.159
Showing off-task behavior	9.73	13.50	-.445	.004
Verbal interaction	113.03	56.11	.349	.027
Total group discourse	159.55	70.00	.271	.090

Title:

Preschool Children at the Interface: A Cognitive Model of Device Difficulty

Author:

Erik Strommen

Cognitive modeling is a method by which data on human performance is quantified and interpreted. In the field of human-computer interaction, cognitive models provide theoretical constructs that attempt to identify the mental processing required to perform a given class of computer tasks, and which try to provide explanations for variations in performance across users and across tasks. Many different types of models exist in the current human-computer literature (c.f. Booth, 1989; Olson and Olson, 1990), and have been successfully applied to a range of computer-based tasks, such as word-processing or automatic-teller usage. It is often argued that this type of modeling provides the most profitable way to assess and predict human performance with the computer, and allows the most penetrating insight into the factors that govern effective human-computer interaction.

While cognitive modeling has been a useful technique for characterizing adult computer use, the suitability of this method for understanding the performance of young children is limited. The basic problem is that for such models to have any predictive value, they must assume generally error-free, on-task performance by the computer user, and that the user's performance is always directed toward solving a clearly defined goal (Booth, 1989; Olson and Olson, 1990). Casual use, where there is no clear goal, or use behavior that is filled with errors or digressions, is not well-captured by cognitive models. Unfortunately, such behavior is typical of preschool children, and thus would appear to make cognitive modeling unsuitable for understanding the performance of such children when using a computer.

The present paper takes the position that cognitive modeling can still be a useful strategy for organizing data on children's performance with computers if the domain being studied is appropriately defined. The current model is concerned with the narrow domain of interface devices for cursor control, and their demands on young children as computer users. The purpose of the model is to provide an initial explanation for the results of several studies of children's use of a variety of different input devices, conducted in the past five years at Children's Television Workshop. **This explanation should be regarded as provisional; future studies will attempt to refine the hypotheses presented here.**

The model

The model begins with the view that cognitive development is accomplished by (1) the acquisition of new concepts, and action schemata, in long term memory; and (2) general increases in cognitive processing power, or short-term working memory, that allow these rules to be efficiently recalled and used dynamically in actual situations (c.f. Case, 1985; Pascual-Leone and Ijaz, 1989). This conception of cognitive growth suggests that young children "fail" tasks that older children and adults can solve because (a) they do not know all the concepts required to perform a given task; and/or (b) they may know all the necessary concepts but lack the mental storage space to activate them all together when needed. Under this theory, young children (the focus of the present model) lack both elements of successful performance. They not only may lack the knowledge required to use a given input device - and need to learn it, a task requiring cognitive effort - but they may also lack the working memory to actively utilize all the knowledge they do have.

The domain of behavior being described is children's competence of use, both initially and after practice, of different "pointing" devices, all of which have the common functions of (1) directing a cursor to select icons on a screen; and (2) activating those icons via a confirmatory keystroke or button press. This behavior is considered to have two additive psychological components: The cognitive demands of cursor control as a behavior, and the pragmatic demands, or "rules," of the hardware device itself that must be followed during use. Both of these components require the activation and use of information that must be either learned or drawn from long-term memory, and both components require working memory during their activation and use.

Cognitive demands of cursor control

This model begins from the assumption that the most natural way for a young child to make choices via a graphic interface is through physical actions that are already natural and familiar to the child, in this case: pointing. Pointing to pictures in books, or to desired objects in the store, school, or home, is a behavior established in infancy. It is assumed here that pointing requires no cognitive effort on the child's part: It is an automatic motor behavior whose execution is completely routinized, with no conscious effort required for its performance. In other words, no working memory is required when the child only needs to point to a choice.

Most computer input devices take advantage of pointing as an easy, swift method for making choices. Evaluations of the design and properties of computer pointing devices recognize that these cursor control devices usually conserve various combinations of the three fundamental properties of human movement that play a role in pointing: direction, distance, and speed (Buxton, 1986; Mackinlay, Card, and Robertson, 1990). The mouse, for example, conserves all three properties of the user's physical movement in the cursor. The mouse's motion on the tabletop is precisely mimicked on the screen by that of the cursor, and positioning the mouse is equivalent to pointing a finger at a choice. The joystick, in contrast, only utilizes the direction of the user's movement. Speed is fixed by the machine, and distance is determined by how long the shaft is pressed - not by any actual distance of the user's movement.

For the present paper, it is argued that the less a pointing device conserves the three properties of movement, the more demanding it will be for young children to use. This increase in difficulty as devices become less like pointing is hypothesized to be due to the fact that children must exert more mental processing effort to anticipate, and evaluate, the movement of the cursor when their own movements are not conserved by it, and that this effort increases with each property of their own movement that is not conserved by the input device. In a sense, the less the cursor responds directly to their own actions, the more it moves "independently" of them, and they therefore must allocate more mental resources to monitoring its movement than they would if it were completely mapped onto their own movements. The model assumes that the mental resources (attention to cursor position and motion, planning of cursor movement, etc.) required when an input device does not conserve the child's own movement are significant, and relatively stable - they do not diminish significantly with experience.

Rules of device use

While the cursor's movement on the screen must be attended to, there is another demand the child must attend to: The rules of device use. Every input device must be used in a specific manner if it is to be used successfully. The particular actions that must be performed with the device to move the cursor (sliding a mouse, rolling a trackball, etc.), other specific actions (keeping a device in the correct orientation, pressing a button to confirm a choice), and other cognitive elements (such as translating the directions of movement of the device to the cursor on the screen) vary with the device used.

This model presents the hypothesis that the more such rules a device requires for use, the more difficult it will be for children to use easily and efficiently, because they consume the child's limited working memory capacity in a manner similar to the demands of cursor control itself. However, unlike the cognitive demands of cursor control described above, this model proposes that device rules differ from cursor control in two ways. First, it is hypothesized that these rules require less resources than cursor control. Second, unlike cursor control, device rules are easily assimilated with experience, and they quickly become "chunked," or automated (Case, 1985), ceasing to require active cognitive processing when they are being invoked. In other words, repeated practice with the rules of device use quickly causes them to become habitual and unconscious, so that the same set of rules comes to require less cognitive effort over time than they required initially.

Relation between demands of cursor control and device rules

The model is based on the hypothesis that the demands on working memory by both cursor control and device rules are additive. That is, the combination of the mental effort required for cursor control and that required for remembering all devices rules sums to the total demand that a particular device makes of the child user. It is hypothesized that children's competence with a given input device is impaired when the combined load on working memory of cursor control and device rules exceeds the child's current working memory capacity.

An additional hypothesis is that when the extra demands of the actual software task itself (solving math problems, finding correct letters, etc.), combined with the demands of the device, exceed the capacity of the child's working memory, the child's ability to control the cursor will be impaired before the child's ability to solve the problems presented by the software. That is, the child will still be able to solve the problem presented by the computer, but will be unable to respond effectively using the input device.

Performance explained by the model

In a series of studies comparing children's use of various input devices (Revelle and Strommen, 1990; Revelle, Strommen, and Offerman, 1990; Strommen, 1993), and in research on specific devices as well (Strommen, 1992; Strommen, Razavi, and Medoff, 1992; Strommen and Revelle, 1990), the results indicated a consistent ranking of devices in terms of the ease of with which children can use the devices to place a cursor on an icon on the television screen (ease is defined both in terms of length of time required to place the cursor, and in terms of total accurate cursor placements). This rank ordering is shown in both Tables 1 and 2, along with an initial analysis of the cognitive demands of both cursor control and use rules for each input device. This ordering is consistent with the hypothesis that the more removed a device gets from the actual physical act of pointing by the child, the more cognitive resources are required by the child to use it effectively.

In addition, the inclusion of device rules explains a unique finding in the three major studies: children's performance with the trackball is consistently superior to that the mouse in the first few days of use. Note that the trackball and the mouse both conserve all three of the dimensions of the child's own actions, suggesting that they make the same demands of the child in terms of cursor control. However, the mouse has many more pragmatic rules associated with its use. These rules hinder children initially, but after several days of practice their competence with the mouse quickly rises to the high level of performance seen right from the start with the trackball.

Current issues confronting the model

Level of detail of the analysis

The current model rests on an assessment of the cognitive demands of cursor control and device use rules. A persistent problem with cognitive modeling techniques is determining the appropriate level of detail that the model needs to specify in order to be accurate: "...the most common predictor of cognitive complexity is the number of rules that are required to describe a task. Unfortunately, the number of rules that are generated by any modelling technique may be dependent not only upon the true complexity of the task, but also upon the grain of the analysis employed (Booth, 1989, p.92)." It is not clear that the analysis of the device rules, or the analysis of cursor control in terms of the three dimensions of pointing behavior, is sufficiently detailed or is too detailed. The validity of the pragmatic device rules, in particular, needs to be more carefully investigated.

A second issue is determining the true cognitive load that the various forms of cursor control actually impose, and the true cognitive load of the device rules, as well. The model current assumes that the cognitive demands of cursor control increase in direct ratio to the loss of movement dimensions conserved. For example, if device rules were all equal, it is assumed that the mouse and trackball would make equal memory demands, and that both would make equally less demands than the joystick, which conserves only one aspect of movement instead of all three. Similarly, the model currently assumes not only that the device rules are all equal in their memory demands, but that they require less cognitive resources than cursor control as a mental act. How much less demand they make is not known. All these assumptions need to be experimentally verified.

Finally, research that links working memory capacity to children's competence when using different input devices needs to be conducted. The current model relies on a specific theory of cognitive development that quantifies working memory in measurable ways. If the present model is correct, it should be possible to associate children's measured working memory with their performance using different input devices.

In conclusion the current model shows theoretical promise as a framework for analyzing children's performances with different input devices, and explaining and predicting differences in competence not only across devices but across children (with differing working memory capacities) as well. It has the potential to provide the first specific conceptual link between developmental psychological theories and children's ability to use interactive technologies, by incorporating competence with input devices into an existing theoretical framework. The model is inadequately specified at present, and specific empirical tests of its constituent features is needed.

Table 1. Cursor control demands of standard input devices, listed by overall ease of use by preschoolers.

Device	Cursor control demands
Touchscreen	None: identical to physical act of pointing
Light pen	None: same as pointing, but with an object as the pointer
Trackball	Minimal: Speed, duration, and direction of ball rotation (child's movement) translate directly into cursor movement.
Mouse	Minimal: Speed, duration, and direction of mouse movement on surface (child's movement) translate directly into cursor movement
Joystick	Moderate/Heavy: Direction is only aspect of physical movement conserved by device
Arrow keys	Heavy: No aspect of movement is conserved by device(s). Directions are separated into unique keys requiring extra step of planning of movement by user.

Table 2. Rules of use of standard input devices, listed by overall ease of use by preschoolers.

Device	Device-specific use rules
Touchscreen	1. Touch desired icon with finger 2. Press button or key to confirm
Light pen	1. Touch tip of pen to desired icon 2. Press button or press pen on icon again to confirm
Trackball	1. Roll ball to select desired icon with cursor 2. Press button to confirm 3. Moving cursor "up" and "down" on screen means rolling ball away from and toward you.
Mouse	1. Slide mouse in desired direction of cursor movement, stopping on desired icon 2. Press button on mouse to confirm 3. Do not move mouse while pressing button 4. Keep mouse flat on surface 5. Keep mouse in correct orientation 6. Moving cursor "up" and "down" on screen means sliding mouse away from and toward you 7. At edge of table, lift mouse and replace in center to continue cursor movement
Joystick	1. Press control shaft to move cursor to icon, release shaft to stop 2. Press button to confirm 3. Moving cursor "up" and "down" means pressing shaft away from and toward you
Arrow keys	1. Press appropriate keys to move cursor to icon 2. Press ENTER to confirm

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Title:

Self Efficacy, Performance Variables and Distance Learning Facilitator Technology Adoption: Support for the Teacher Needs Hierarchy

Authors:

R. S. Talab
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Innovation and Teacher Technology Adoption

Several investigators have pointed out that the success of reforms which rely on "outside" change agents, without sufficiently involving teachers, has been dismal (Aust, Bichelmeyer, & Allen, 1991; Dwyer, Ringstaff, & Sandholtz, 1990; Janowitz & Street, 1966; Johnson & Keller, 1981; Martin & Clemente, 1990). Cuban (1986) observed that

> teacher expertise [is] drawn from a pool of craft wisdom about children and schooling that dances beyond the limited understanding of nonteaching reformers... (pp. 5-6).

Snyder (1986), citing a Rand Corporation study of school innovations, observed that it is simplistic to assume that any new technology, regardless of how good it is, can be meaningfully adopted and maintained in the school system unless it takes into consideration the social and political climate of the school and places the teacher at the "dead center of the loop". "Historically, teachers use technologies that buttress, rather than undermine, their authority" (Bichelmeyer, 1991).

Investigators have found that teachers adopt new technological innovations around a cluster of factors: simplicity, durability, reliability, versatility (Johnson & Keller, 1981; Rogers, 1983), flexibility, time, communication (Kell, et. al., 1990), and developmental input (Aust, et. al., 1989). Kell and others (1990) reinforced these findings by naming five conditions that are conducive to change in the classroom: 1) a shared vision of teaching and learning, 2) leadership and support for new technology, 3) organizational conditions allowing flexibility, time, and incentives, 4) peer networking, and 5) training and personalized support.

Bichelmeyer (1991) expanded on these factors by proposing that teachers adopt technology innovations in a hierarchy of needs based on Maslow's Hierarchy (1968), with the most basic needs generally being fulfilled before higher ones: 1) time and accessibility, 2) dependability, 3) ownership and authority, 4) control, and 5) integration.

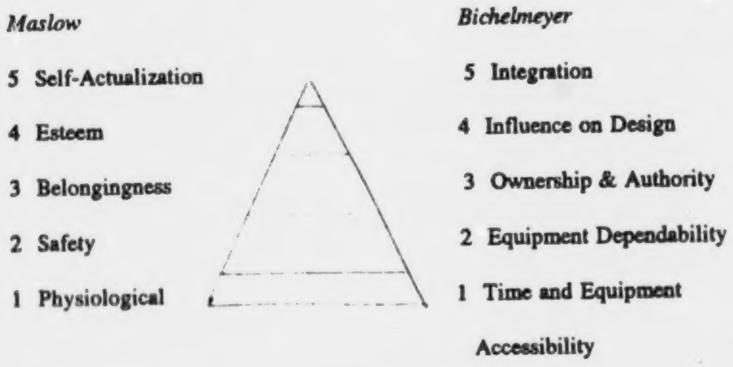
Maslow
5 Self-Actualization
4 Esteem
3 Belongingness
2 Safety
1 Physiological
Bichelmeyer
5 Integration
4 Influence on Design
3 Ownership & Authority
2 Equipment Dependability
1 Time and Equipment Accessibility

Figure 1: Hierarchy of Needs and Hierarchy of Teacher Technology Needs

Teacher Needs, Empowerment, and Technology Integration

This model is based on empowerment and accounts for 1) the centrism of the teacher, 2) the politics of the school, and 3) the practical logistics of classroom technology incorporation (Jackson, 1968; McDonald, J. 1989).

> "...Technological innovations that have been embraced by teachers are those that have solved problems which teachers themselves identified as important, regardless of what non-teachers say" (Bichelmeyer, 1991).

No other model of teacher technology adoption accounts for all of the above three factors.

Self-Efficacy and Technology Adoption

Central to the concepts of ownership and authority is "self-efficacy". Bandura's (1977) theory states that people develop beliefs concerning their own coping capabilities. The extent to which a belief is internalized by the teacher affects the value of an endeavor to that teacher. Teachers that internalize or vest a concept thereby increase their effectiveness in its use (Brophy, 1979; Gibson & Dembo, 1984). Teachers who believe that they have successfully integrated new technology tend to be teachers who successfully integrate technology into their instruction (Riggs, 1988). "If I master it, then I can internalize it" (Bichelmeyer, 1991, p. 138).

The Distance Facilitator as Technology Adopter

Satellite-based instruction is an instructional delivery mode serving over 125,000 students in 45 states through the S.T.A.R. Schools program alone (Office of Educational Research and Improvement, 1992), as well as other other independent and consortium providers, such as The Kansas Regents Educational Communications Center, TIE-IN, SERC, etc. While the distance facilitator's role varies somewhat worldwide (Harry, 1982; Parer, 1990; UNESCO, 1987), in the United States the term "distance facilitator" means anyone who facilitates distance learning--certified or uncertified and regardless of their duties. The "Teaching Partner" is generally a certified teacher who must learn a subject along with the students, provide course and equipment support for a high school distance class, and often must learn along with the students.

The distance facilitator plays a crucial role in student recruitment, retention, and persistence (Hobbs, 1990; Laube, 1992). Distance facilitators are considered necessary for effective foreign language instruction (Grier & Nelson, 1990). Research and evaluation data on distance facilitators in the United States have found that they have an average of four other preparations, are mid-career, are selected by their principals (rather than voluntarily asking to be assigned as facilitators), and are anxious about using new technology, such as satellite receivers, computers, and data streaming equipment (Dillon, 1990; Ford, 1990; Hobbs, 1990). Principals' reasons for facilitator selection are based on subject background, availability, and general teaching ability (Talab & Newhouse, 1990).

Research indicates that teachers and instructional designers are involved in similar basic activities (Applefield & Earle, 1990; Branch, Darwazeh & El-Hindi, 1992; Gagne, Briggs & Wager, 1992). Earle (1992) found that teachers believed that a knowledge of instructional design processes improved their planning. It is likely that these same processes may be internalized and thereby integrated through the facilitation of satellite instruction. For example, course elements include the regular observation of a "master teacher," training in the use of carefully selected print, non-print, and instructional materials (syllabi, tests, worksheets, etc.), hardware training, and the chance to network with other facilitators on course progress (Talab, 1991a). Typical comments of distance facilitators about the teaching/learning experience are that they have gained from learning from an excellent teacher and that they professionally benefited from the opportunity to network with other teachers on methodology (Dillon, 1990).

Purpose of the Study

The purpose of the present study is to examine self-efficacy and performance variables and technology adoption for secondary distance learning facilitators. Secondary distance facilitators are a group that must, by the definition of satellite-based education, adopt the most recent technological advances available for instructional development and delivery. There are many differences between adult distance learning and learners and secondary distance learning and learners (Laube, 1992). To date, these issues have yet to be addressed.

Hypotheses

In order to find if any relationships existed between certain ownership/self-efficacy ("vesting"), performance variabies and technology adoption the following hypotheses were developed:

1. A high vester will be more committed to continuing as a distance facilitator than the low vester.
2. A high vester will perceive him/herself as a more effective distance facilitator than the low vester.
3. A high vester will feel more comfortable with with new technology than the low vester.
4. A high vester will be perceived by the principal as being a more effective distance facilitator than the low vester.

Methodology

Subjects and Setting

The subjects were 107 high school teachers who served as distance facilitators for an introductor Spanish course offered by the Regents Educational Communications Center (RECC) at Kansas State University. The course is offered in nine states: Alabama, Colorado, Kansas, Missouri, Mississippi, Montana, Oklahoma, Tennessee, and West Virginia. The RECC (and Kansas law) requires the presence of a distance facilitator ("teaching partner") for satellite-based courses. This person must be a certified teacher and the RECC requires that he/she learn Spanish along with the students. Training is not required for Teaching Partners, but most do take part in training and some come year after year. During training discussion groups for new (Spanish One) and experienced (Spanish Two) Teaching Partners were formed and surveys were conducted for formative evaluation purposes.

Variables

Variables for the Teaching Partner survey were based on Bichelmeyer's (1991) Hierarchy of Needs and Bandura's (1977) concept of self-efficacy. Self-efficacy refers to the internalization of a practice or principle and corresponds to the ownership and authority (3rd level) of the Teacher Needs Hierarchy. In Maslow's Hierarchy of Needs level 3 would be Belongingness.

The performance variable chosen was instructional design. If teachers felt that as a result of their being distance facilitators they could design instruction with new technology then they would likely exhibit more effective teaching performance with technology.

Instructional Design. They were asked if, as a result of
being a Teaching Partner, they knew the steps necessary
to using technology in the instructional setting.

Three self-efficacy variables were tested against the performance variable.

Teaching Partner Commitment. They were asked if they
would like to continue as a Teaching Partner.

Responsiveness to New Technology. They were asked if they were more comfortable with using new technology as a result of being a Teaching Partner.

Role Effectiveness. They were asked if they were performing their duties well.

Instrumentation

In order to assess the relationship between ownership/self-efficacy (vesting) variables and performance an 81-item questionnaire was developed for Teaching Partners. The response format to questionnaire items varied and included items developed on a five, four, and three point Likert scale, multiple choice, and open ended response items. Eleven of the questions were adapted from Riggs' Science Self-Efficacy Instrument on Microcomputers (Riggs, 1988). The reliability of the performance variable was .82 and the reliability of the self-efficacy variables were: Variable 1 (commitment):.72, variable 2 (technology adoption):.81, variable 3 (role effectiveness):.75

A thirteen-item phone survey was constructed for Principals consisting of five point Likert, multiple choice, and open ended response items. In order to clarify survey questions an open-ended interview was conducted with sixteen Spanish One Teaching Partners participating in training.

Procedures

Questionnaires with stamped return envelopes were mailed in May, 1991, to all 107 distance facilitators. After two mail followups in July and August, 89 questionnaires were returned by late September, resulting in an 81% response rate. Phone surveys were conducted with 32 principals in late May and early June, constituting a one in five sample. After dropouts 29 facilitator-principals pairings were available for analysis.

Statistical Analyses

The first three hypotheses were tested by use of Chi Square analyses (with Yates Correction) comparing subjects' self-efficacy to performance variables. This was accomplished by dropping the "undecided" group from the 5-part Likert scale and dividing the remaining groups into either high or low. The last hypothesis was tested using the Pearson Product-Moment Correlation to see if a relationship existed between self efficacy and principals' perception of Teaching Partner performance. Responses from the open-ended interview with Spanish One Teaching Partners were examined using a content analysis.

Hypothesis One

The results of the Chi Square test were significant (X2=6.54, df=1, p<.01) indicating that the high vester group differed significantly from the low vester group in their commitment to continuing as a Teaching Partner (see Table I).

Table I = Comparison of Self-Efficacy and Commitment

	Commitment		
Group	*No*	*Yes*	*Total*
Vesters	-0-	26	26
Non-Vesters	3	5	8
Total	3	31	34

X2=6.54 df=1 p.<.01

Missing Observations: 21

Hypothesis Two

The results of the Chi Square test were significant (X2=15.29, df=1, p<.0001) indicating that as a result of being Teaching Partners they feel comfortable with new technology.

Table 2 = Comparison of Self-Efficacy and Technology Adoption

	Technology Adoption		
Group	*No*	*Yes*	*Total*
Vesters	-0-	36	36
Non-Vesters	3	2	5
Total	3	38	41

X2=15.29 df=1 p<.0001

Missing observations = 14

Hypothesis Three

The results of the Chi Square test were significant (X2=3.99, df=1, p< .04) indicating that the high vester group differed significantly from the low vester group in their role attitudes.

Table 3 = Comparison of Self-Efficacy and Role Effectiveness

	Role Effectiveness		
Group	*No*	*Yes*	*Total*
Vesters	1	35	36
Non-Vesters	1	-0-	1
Total	2	35	37

X2=3.99 df=1 p<=.04

Missing Observations = 18

Hypothesis Four

The data were inconclusive. A Pearson Product-Moment Correlation could not be done due the absence of comparable cells. Most principals rated the quality of the facilitator's performance highly, answering on a five-part Likert scale either "excellent" (14) or "very good" (13), for a total of 27 that were rated highly. One principal was also a facilitator and could not be included. One facilitator was judged to be "very poor" but responded in high vester group in all previous measures. No explanation was offered by the Principal for the poor evaluation. In addition, principals may have answered more positively in a phone interview than by mail, as principals will respond more positively to questions from interviewers from the RECC host campus phone survey for which they might be identified than those for which remain anonymous (Talab, 1991b).

Content Analysis of Facilitator Responses to Open-Ended Survey

Subjects were asked to identify what concerns they had as Spanish One facilitators. A total of 16 subjects provided responses, and most gave multiple responses for a total of 34 responses. A content analysis was conducted in order to aggregate similar responses into categories. Facilitator responses are ranked in order of frequency of response for each category. The results were two areas of concern: 1) instructional design (Table 5) and 2) classroom management (Table 6).

Table 5: Summary of Content Analysis of Facilitator Instructional Design Concerns

Identified Concerns	*Frequency of Responses**	*Rank*
differences between book emphasis and tv professor emphasis	6	1
course element timing during school year	6	1
the need for an anticipatory set	5	2
problems with question cards	4	3
should students write or speak first	4	3
coordinating activities	3	4
who speaks when on camera	3	4

*Total number of subjects responding = 16

Table 6: Summary of Content Analysis of Classroom Management

Identified Concerns	*Frequency of Responses*	*Rank*
School Schedules	9	1
planning time to work on materials	7	2
difference between facilitating and traditional teaching	6	3
need for in-class time for student work	5	4
varied responsibilities	3	5

*Total number of subjects responding = 16

Other statements of interest made by facilitators were that satellite-based instruction made the students responsible, that they learned to become better learners, and that other teachers were skeptical of facilitators because it looked like it was easy. Most (14) participants agreed that it was just as difficult as traditional teaching. Two participants believed that it was more difficult because of the management and technological demands.

Conclusions

Among the three self-efficacy variables tested for high and low vesters against the performance variable, there was a significant positive relationship found between instructional design and 1) commitment, 2) responsiveness to new technology, and 3) role effectiveness. No statistically significant relationship was found between principals' evaluation of facilitator performance and facilitators' self-appraisal.

Commitment

The results of this study support the findings of others (Bichelmeyer, 1991; Dillon, 1990; Reezabek, 1991; Talab & Newhouse, 1990). Mastering the technology for instruction was in large part a reason for facilitators to continue. It must be noted that facilitators generally do not volunteer and are hesitant about using technology (Hobbs & Osbourn, 1989). However, commitment to continue seems to be related to a large extent on program training and to a lesser extent on program implementation rather than the mere adoption of the technology or the position itself (Ford, 1990).

Technology Adoption

The finding that facilitators feel more comfortable with adopting new technology as a result of being a facilitator corroborates earlier research that presents a surprising consensus on faciliator duties, with one of the major duties being equipment operation (Simonson, Johnson & Neuberger, 1989; Mihalevich, 1990; Talab, 1990a). Kell et. al.'s finding (1991) that familiarization with the many forms of media and technology that are used in an exemplary class is also meaningful with regard to facilitator exposure to technology adoption through combined with training and modeling by the master satellilte teacher. The one "caveat" is that technology training must be executed properly and technology implementation must be aided by communication with course personnel, since facilitator-perceived weaknesses with satellite-based instruction training center on technology and equipment training (Ford, 1990).

Role Effectiveness

The findings support those of Hobbs (1989) and Ford (1990) because of the high degree of instructional technology that must be mastered in order to fulfill the role. It seems evident that those who do feel that they have a high degree of self-efficacy in instructional design with technology would feel that they fulfill their role to a high degree (Reezabek, 1991).

Principals' Perceptions of Facilitator Role Effectiveness

The inconclusive findings could be indicative of either a high approval rating or an unwillingness on the part of principals to appear that satellite-based education is anything other than successful (Talab, 1990b). A feeling that is generally shared by school adminstrators, more so than facilitators, is that satellite-based instruction is an effective and inexpensive way to bring college preparatory instruction to rural and underserved areas and this could account for a generally positive response (Hobbs, 1990).

Discussion

The Importance of the Teacher Needs Hierarchy in School Restructuring

Support for this model can be drawn from the concept of self-efficacy. High vesters are different from low vesters in their commitment, role effectiveness, and responsiveness to new technology. They believe in their own abilities to design instruction using new technology as a result of being distance facilitators. In many ways they are representative of all teachers in their hesitance to learn the technology and the fact that they are generally selected to be facilitators rather than volunteering themselves. Yet they believe that as a result of being teaching partners they are now able and willing to continue in this role. By all accounts, distance facilitators have successfully incorporated technology into their classrooms in an exemplary manner.

The question then becomes "why are the results so positive with satellite-based education in contrast to computer integration?" There could be several reasons. Studies show that teachers who become facilitators are no more conversant or willing to use satellite technology than they are to use computers (Hobbs, 1990; Reezabek, 1991; Talab & Newhouse, 1990). Yet most facilitators:

1) are committed to the concept of equality of education (college preparatory courses for underserved students) that satellite-based education provides,

2) see opportunities for professional advancement through learning new skills and professional networking;

3) seem revitalized by the observation of a master teacher and exceptional instructional design,

4) realize that the program will not work without their participation,

5) receive training in satellite-based instruction, either live or on tape, professional troubleshooting, and program feedback.

These findings also corroborate Bichelmeyer's Hierarchy of Teacher Needs because teachers are given time and accessible equipment (level 1), program personnel help them with machine operation and troubleshooting (level 2), they take part in training, program planning, and control the grading, classroom management, and classroom activities (level 3), they influence the program through feedback (level 4), and they see the need for technology integration in order to take part in the program (level 5).

While there is no research on the differences between facilitators and other teachers, a possible answer could be that the difference is philosophical. Teachers must indeed "internalize" the use of a new technology if the use is to be long-term and involve more than just the standard "top-down"--principal-teacher authority structure that has operated in traditional education. Restructuring with technology must take into account the teacher's: 1) centrism, 2) authority base, and 3) design involvement. Ravitch (1993) states:

> School organization has been traditionally hierarchical, bureaucratic....New technologies challenge this model.

We must recognize that one of the main reasons that new technologies have not been incorporated into the schools after their initial introduction is that the teachers have not been recognized as motivating forces but as workers. Teachers are the instructional leaders of their classrooms, yet their importance as individual authorities has been ignored, in the planning, introduction, and execution of many new programs (Cicchelli, 1982; Lipsitz, 1989). Meaningful adoption based on what is sure to be constant change requires the use of a new model.

Technology Adoption: Is it Exemplary in Distance Education?

There are five major issues in distance education: 1) a critical/reflective framework for the field, 2) access and equity, 3) dialog and independence, 4) technology, and 5) third world development (Evans & King, 1991). Distance learning technology changes rapidly, requiring constant adaptation (Pelton, 1990). Technology adoption is a key issue in distance facilitation because it is technology-dependent. Perhaps the issues and theory base that undergird distance education and make it successful in the introduction of technology needs to be examined in school technology integration.

The Need for a Pre-College Theory Base of Distance Education

The fast-growing use of satellite-based instruction, with another four consortiums being awarded a total of $18.2 million for the next two years (Electronic Learning, 1993), brings to 10 the number of multi-institutional consortiums that have received Star School funding. The need to look closely at the unique characteristics of high school distance education United States and Canada is now.

The research of Laube (1992) and others (Dillon, 1992; Speth, 1992; Speth, Poggio, & Glasnapp, 1992) working primarily with secondary distance education in the United States and Canada clearly show "no consistent trend with the findings...found in adult education" (Laube, 1992). The operating assumptions are different. Secondary students have different motivations, controls, and restrictions than do adult students. Secondary distance facilitators have different time and professional constraints, as well. With the use of distance education around the world in the pre-college setting and the rapidly growing population of United States and Canadian secondary distance learning it is essential that a theory base be constructed in order to better serve this constituency.

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Title:

The Effects of Cooperative Learning and Learner Control on High- and Low Achievers

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Abstract

We investigated the effects of studying alone or in cooperative-learning groups on the performance of high and low achievers. We also examined the effects of completing computer-based instruction using either learner- or program-control. A total of 92 sixth-grade students were classified by Stanford Achievement Scores and randomly assigned to group or individual treatments, stratified by achievement scores. Students completed training to enhance small group interaction before completing the computer-based tutorial and post-tests. Both high and low achievers in the cooperative treatment increased achievement on program-controlled and learner-controlled computer lessons. The learner controlled cooperative learning group made more options while checking their concept learning, and spent more time interacting with the learner-controlled computer-based tutorial, than the learner-controlled individual learning group.

The Effects of Cooperative Learning and Learner Control on High- and Low Achievers

Designers of instruction agree that it is important to identify how the instructional environment can be organized in order to utilize the relevant cognitive processing capabilities of learners, and to examine the manner in which technology facilitates such processing (Gagné, 1987). One strategy, which is the subject of debate, is the effect of the shared learning procedures that occur when students work in groups in a mediated instructional environment using modern technological media (Hooper & Hannafin, 1988). Although research on cooperative learning has been conducted to maximize the cost-effectiveness of existing media, it is beginning to reveal the cognitive processing potential when students are allowed to make joint decisions regarding their instructional needs (Johnson & Johnson, 1989).

To date, there are few studies that have focused on cooperative learning groups with computer-based instruction, which enable learners to work in program-controlled situations. Another area of research, which has become popular with the increasing use of computers in education, is that related to delegating some instructional decision-making to learners. Using the capabilities of computers, it is possible to incorporate several types of control strategy in the instruction.

The purpose of this study is to examine two factors that influence the effectiveness of computer-based instruction (CBI) on promoting learning: cooperative group learning and learner control. We propose that efficient use of observation and peer modeling (Bandura, 1977) are powerful mediators of improved performance. However, younger or less-skilled learners are often lacking in knowledge of the use of strategies, as well as how to monitor strategy use when given the opportunity to do so. In cooperative learning groups that are heterogeneous with respect to ability, low- and high-ability students will have an opportunity to observe each other's option-selection skills. This research will investigate whether students in cooperative learning groups will help each other monitor the skills required for learner-controlled behavior and improved decision-making, while learning from a computer-based instructional environment. The present study is an attempt to explore the cognitive and metacognitive assumptions underlying choice behavior and performance in a learner-controlled environment. In the current research we hypothesize that children's knowledge, use, and monitoring of cognitive strategies—especially those related to the decisions made during computer-based instruction—may be inefficient, resulting in poor performance and non-strategic use of available options. For example, it is not sufficient to merely provide learners with options in a lesson, without guidance on how to use them wisely (Boyd, Douglas & Lebel, 1984; Tobias, 1987). Learner control can be considered a meta-strategy, in which learners must exercise a high level of self-monitoring.

One of the goals of instruction is to promote independent, life-long learning. This goal may be promoted by encouraging students to exercise learner control. Learner control refers to students' freedom to manipulate the instructional sequence. In CBI, designers may allow students considerable freedom (or they may impose rigid control) to choose the number of examples and questions, which instructional components to complete, and when to quit instruction.

A large body of research suggests that students often perform poorly in learner-controlled conditions (Steinberg, 1989). However, this effect is mediated by achievement. High achievers appear to exercise effective learner control, but low achievers perform particularly poorly under such conditions. Low achievers often lack sufficient self-regulatory strategies to make effective learner-controlled decisions.

The effect of peer interaction on students' proficiency in making effective decisions has not been examined. Yet, related research suggests that low achievers may work effectively in learner-controlled conditions, when paired with a more capable partner. High-achieving students often model effective learning strategies to less capable partners (Bandura, 1977). We predict that students in the learner-controlled conditions will learn more effectively in groups than with individual treatments.

The purpose of this study was to extend previous research comparing the effects of completing CBI in groups and alone. The study examined the effects of cooperative versus individual CBI on the performance of high and low achievers. The study also examined the effects of learner and program control in individual and cooperative treatment. Finally, the study investigated students' option within learner controlled group to see the effects of time and number of options on individual and cooperative treatments.

Method

Subject

A sample of 92 sixth-grade students from a predominantly white suburban school, participated in the study. Participation was voluntary, and only those who had parental consent were included. The standardized reading scores of this sample were obtained from the SAT (Stanford Achievement Test) test battery administered at the beginning of the academic year (Mean= 48.01 , Range= 2 to 95 , SD= 26.95). Students were classified as high or low achievers according to performance on the reading subscale of the Stanford Achievement Test.

Materials

The following materials were used for the study.

Standardized scores

Standardized achievement test scores in reading ability and overall scores were collected at the beginning of academic year and before the study. Because the experimental content is highly verbal (textual) in nature, these scores were used to form the heterogeneous learning pairs. Reading ability has been found to predict performance in a learner-controlled task based on science content (eg., Kinzie, Berdel and Sullivan, 1988).

Computer-Based tutorial

The computer-based tutorial used for the study was designed and developed by the experimenter using biological concepts that were used in another study on learner-control (Relan, 1991). Several steps were involved in the selection of content, design, and development of the tutorial.

Selection of content The topic of Ecology was selected because of the requirement from the principal and sixth-grade teachers in this elementary school. Content was selected with the objective of identifying level of learning outcomes (Gagné, Briggs, and Wager, 1988). Definitions and instances of ecological topics were excerpted from biological ecology texts ranging from sixth-grade to college-level textbooks. These were paraphrased to accommodate the text to the target population according to the purpose of the study.

The topic selected was "Relationships among Organisms," which included two types of relation: friendly and unfriendly. Six topics were identified for inclusion in the lesson: Mutualism, Commensalism, Competition, Parasitism, Exploitation, and Predation.

Post-test. A 25-item multiple-choice test on generalization, based on verbal and inferential learning outcomes, was implemented as both immediate and delayed post-tests. This test was used in previous research and had been tested for reliability ($\alpha = .79$).

Dependent Measures

Three measures were obtained for each individual student: achievement, time, and options. Achievement was obtained through the immediate and delayed post-tests. Time was collected during the computer-based tutorial. Options were the numbers of options that students made during the tutorial in the learner-controlled treatment.

Design The study employed two designs. For individual measures, a randomized block design was employed with two cross-experimental factors, Grouping (individual or cooperative) and Source of Control (learner or program), and one blocking factor, achievement (high or low). Because the effects within treatment levels were not of particular *a priori* interest (i.e., high achievers were always expected to outperform low achievers on the post-tests), the achievement by treatment interaction effect was partitioned into those effects of more interest in this study. That is, the effects of source of control and Grouping were examined within each achievement level. The full design model is reflect in Table 1. For learner control-based performances, a completely randomized design employed with two crossed-experimental factors:Grouping (individual or cooperative) and Level of Achievement (high or low).

Insert Table 1 about here

Experimental Procedures

During the week before the experiment, students completed a training session. Training lasted approximately 50 minutes, and was completed in an intact class.

Subjects were assigned to treatments using stratified-ramdom sampling. Initially, high-and low achievers were randomly assigned to paired- and individual-treatment groups. For each class, subjects in the paired treatment were ranked within each achievement level group. Partners were assigned by combining students with identical ranks: The highest achiever was paired with the one who scored just below the median; the second highest was paired with the subject who had the second score below the median and so on, such that the student just above the median was paired with the student who had the lowest score. In this way, there was always a difference between partners of at least 1.5 standard deviation in the SAT score, and, heterogeneity among group members was established. Other students worked individually. The immediate post-test was administered on the same day, after the computer-based tutorial. One week following the experiment students completed the delayed post-test individually. Three absentees completed the post-test two days later. Ninety-two subjects completed the study.

Results

The results are presented in two parts. First, results are reported for individuals. Reliabilities and inter-correlations among the dependent measures are presented, followed by separate MANOVAs examining various treatment effects. Subsequently, results are reported for each of two sets of variables on individual students: immediate post-test and delayed post-test. The second set of results are group-based measures. Group-based measures reflect data recorded at each computer. Each pair of students in the cooperative groups produced a common data set and is thus treated as one case.

Calculations were made using the Statistical Package for the Social Sciences (SPSS) 4.0 for Macintosh, (@ 1990, SPSS Inc.). All tests of significance adopted an alpha level of .05. Inconsistent sample sizes reported across the Tables reflect subjects with isolated missing data points.

Individual Results

Inter-correlations and Scale reliabilities The multiple choice test on generalization was used as both immediate and delayed post-tests. A preliminary correlational analysis was performed to examine the relationships among significant variables in the study. Results of this analysis are shown in Table 2. Table 2 presents inter-correlations among all the immediate post-test, delay post-test, reading and overall scores of the Stanford Achievement Test. All achievement variables were highly correlated: The two post-tests were significantly correlated and were also related highly with both reading subscale and over all Stanford achievement scores.

Insert Table 2 about here

Table 3 reports means, standard deviations, and alpha coefficient reliabilities of immediate and delayed post-test. The immediate post-test reliability was .67. The delayed post-test reliability was .73.

Insert Table 3 about here

Post-tests. Table 4 reports the means and standard deviations of immediate and delayed post-test scores for treatment effects within level of achievement groups.

Insert Table 4 about here

The immediate post-test shows that learner control cooperative treatment scores (M=12.75, SD = 4.99) were higher than any other treatment scores, within high achievers. However program control cooperative treatment scores (M=8.91, SD= 3.15) were higher than any other treatments within low achievers.

The delayed post-test also shows that learner control cooperative treatment scores were higher (M= 15.42, SD= 4.34) than any other treatment scores within high achievers. Program control cooperative treatment scores (M=11.36, SD= 2.29) were higher than any other treatments, within low achievers. It appears that the high achievers performed better under the learner-control cooperative treatment than the program-control cooperative treatment and both learner and program control individual treatments. On the other hand, the low achievers performed better under the program-control cooperative treatment than the learner-control cooperative treatment and both program control and learner control individual treatments. However there are no significant differences for the control main effect.

On the delayed post-test, the MANOVA indicated significant effects for grouping within the high achievement group (F=11.57, p<.001) and for grouping within the low achievement group (F=4.69, p< .05). Both high and low achievers learned more effectively in the cooperative treatment than in the individual treatment.

Group Results (Learner-controlled options)

Table 5 reports the means of the five performance indicators during the learner-controlled lesson across Grouping (Individual and Cooperative) and two level of achievement (High and Low). Learner control cooperative treatment has the highest means of Time on task and Checking the concept learning.

Insert Table 5 about here

A MANOVA on the five performance indicators (time on task, total checking, total review, total elaborative feedback, and total practice) was performed to compare the differences in performances during learner control between low and high achievers working individually and high and low achievers working in cooperative pairs. Results of the MANOVA indicated that there are significant differences between the two performance indicators, which are the time on task (df= 2, 27, F=8.82, p= .001) and the number of learning checks for each concept (df= 2, 27, F= 4.08, p= .028). Univariate follow up tests indicated that high and low achievers working together in cooperative treatment pairs spent more time and checked their learning more for each concept than high and low achievers working alone. The levels of significant differences are shown in Table 6.

Insert Table 6 about here

Discussion

The purposes of this study were to examine the effects of completing CBI alone and in cooperative learning groups on high and low achievers and effects of studying in learner- and program-controlled treatments. Cooperative learning improved the achievement of both high and low achievers. The cooperative learning groups demonstrated higher delayed post-test achievement than the individual learning groups.

During the learner-controlled lesson, cooperative learning groups spent more time interacting with the lesson; they also checked their concept learning more than those in individual learning groups. We interpret these findings to mean that cooperative learning mediates deeper content processing and that achievement gains are the result of greater exploration in the learning process. These results also support the previous study (Hooper, Temiyakarn, and Williams, 1991, in press). This is important because it challenges the notion that heterogeneous cooperative-learning groups interfere with the performance of high achievers.

However, the learner control effect is mediated by achievement (Carrier and Jonassen, 1988). Most research on learner control suggests that high achievers appear to exercise effective learner control, but low achievers perform particularly poorly under such conditions. Low achievers often lack sufficient self-regulatory strategies to make effective learner-control decisions. However, the effect of peer interaction on students' proficiency in making effective decisions has not been examined. This study suggests that low achievers may work effectively in learner-controlled conditions, when paired with a more capable partner. High-achieving students often model effective learning strategies to less capable partners (Bandura, 1977). This study shows that low achievers in the learner-controlled conditions learned as effectively as in the program-controlled condition when they were in groups than when they were in individual treatments.

The absence of significant achievement differences between program-control and learner-control treatments indicates that some students may have interacted with the lesson content superficially. Previous research indicates that low achievers did poorer using learner control than using program control (Carrier and Jonassen, 1988). However, this study shows no differences between program control and learner control within low achievers. Thus learner control promoted the bigger mean within high achievers.

The results of this study suggest that greater attention should be given to designing CBI for cooperative learning groups, rather than individual learning. CBI and interpersonal interaction promoted by cooperative learning provide encouragement to stay on task and exert mental effort to both low and high achievers. In the cooperative learning environment, high and low achievers explore diverse ideas and procedures of learning (McDonald, Dansereau, Garland, Holley, & Collins, 1980). Together, computer-based instruction, learner control, and cooperative learning magnify each others' benefits.

Future research should pay strong attention to using the powerful learner- controlled treatment to improve achievement, and using the cooperative learning to promote learner control, for both high and low achievers. Learner-controlled lessons should be carefully designed for computer-based tutorials. Learner control with advisement may be appropriate to adapt the student to start with a program-controlled environment and gradually move to a completely learner-controlled lesson, when ththeir learning for each conceptey are ready for such strategy. Modifications of this experimental design may enable exploration of other factors that enhance learning within the learner-controlled situation.

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Table 1

MANOVA of treatment effects on the post-tests within low and high achiever groups.

Effect	df	F	p
Immediate			
Blocking factor:			
Achievement Level	1, 91	30.90	.000
Treatments within Low Achievers:			
Grouping	1, 91	2.27	.136
Source of Control	1, 91	.07	.787
Grouping by Source of Control	1, 91	.12	.729
Treatments within High Achievers:			
Grouping	1, 91	.83	.364
Source of Control	1, 91	.64	.425
Grouping by Source of Control	1, 91	1.39	.242
Delay			
Blocking factor:			
Achievement Level	1, 91	21.00	.000
Treatments within Low Achievers:			
Grouping	1, 91	4.69	.033
Source of Control	1, 91	.98	.324
Grouping by Source of Control	1, 91	.84	.363
Treatments within High Achievers:			
Grouping	1, 91	11.57	.001
Source of Control	1, 91	.06	.811
Grouping by Source of Control	1, 91	1.43	.235

Table 2

Correlations between independent and dependent variables of interest in the study.

	Immed. Post-test	Delay Post-test	SAT
SAT Reading	.6539**	.5766**	.8721**
SAT	.6711**	.6406**	
Delay Post-test	.7966**		

Note. ** implies p<.01.

Table 3

Means, standard Deviation, and Reliabilities for the achievement Measures

N=92

	Scale Mean	Standard Deviation	Coefficient α
Post-test			
Immediate	10.03	3.93	.67
Delay	10.91	4.34	.73

Table 4

Means and standard deviations of immediate and delay post-test scores by treatments.

Level of Achievement	Level of control and Grouping: LC Ind.	LC Coop.	PC Ind.	PC Coop.	Total
Immediate					
High					
N	10	12	11	11	44
Means	10.60	12.75	12.64	12.36	12.14
SD	3.95	4.99	3.67	4.57	4.28
Low					
N	13	12	12	11	48
Means	7.69	8.83	7.08	8.91	8.10
SD	1.93	2.33	1.08	3.15	2.28
Delay					
High					
N	10	12	11	11	44
Means	10.30	15.42	11.36	13.82	12.84
SD	3.40	4.34	4.99	5.90	5.03
Low					
N	13	12	12	11	48
Means	8.00	9.33	8.08	11.36	9.13
SD	2.48	1.72	2.58	2.29	2.60

Note. Maximum points possible = 25.

Table 5
Learner control options

Level of group within learner control	Types of Options				
	Time	Check	Review	Elaborative Feedback	Practice
Individual					
Low achievers					
N	10	10	[illegible]	10	10
M	24.00	4.10	80	5.00	22.20
SD	5.23	3.51	79	4.83	6.73
High achievers					
N	10	10	0	10	10
M	23.60	3.70	70	5.30	21.00
SD	2.84	3.34	82	4.92	4.92
Cooperative					
High & Low					
N	10	10	0	10	10
M	31.20	7.20	.70	8.90	20.60
SD	5.18	1.87	06	4.95	4.90
Total					
N	30	30	[illegible]	30	30
M	26.67	5.00	.73	6.40	21.27
SD	5.65	3.30	.87	5.06	5.43

1034

Table 6

MANOVA of treatment effects on the options within cooperative learning groups.

Variable	df	F	p
Time on task	2, 27	8.82000	.001
Checking Concept Learning	2, 27	4.08450	.028
Review Each Concept	2, 27	.04128	.960
Elaborative Feedback	2, 27	1.95948	.160
Practice Items	2, 27	.22233	.802

Title:

Faculty Concerns as Gateways to Teacher Competency with Computer Technologies

Author:

Nancy L. Todd

Faculty Concerns as Gateways to Teacher Competency with Computer Technologies

Introduction and Background

Teacher preparation programs are faced with providing computing experiences by faculty who often have limited computing experiences and insufficient resources. The International Society for Technology in Education (ISTE, 1992) developed standards in educational computing applications for beginning teachers. Those standards have also been approved as accreditation standards by the National Committee for Accreditation of Teacher Education, thereby increasing the pressure on Education programs to integrate educational computing components within courses. Determining needs of faculty for staff development and resource acquisition is an important step in the planning process.

The purpose of this study was to determine faculty concerns about integrating computers in teacher education courses. Education faculty responded to the Stages of Concern About an Innovation Questionnaire [SoCQ] (Hall, George & Rutherford, 1977) and discussed their concerns in interviews. Two questions guided this study. First, what are faculty concerns when considering integrating computer-based technologies in courses? And second, because some faculty had experience integrating computer activities in courses, what different concerns are there between those who have had that experience and those who have not?

The Concerns-Based Adoption Model [CBAM] provided the conceptual framework for this study. This theory assumes that change is a process that follows a seven stage developmental sequence regarding the concerns that faculty have when an innovation is adopted (Hall & Hord, 1987). This theory drew upon Fuller's (1969) work about the developmental nature of teacher concerns. She posited that preteachers are largely preoccupied with self concerns. As student teachers, they become concerned about managing the tasks of teaching. With more experience, they become concerned about impact on students. Hall, Wallace and Dossett (1973) found that these three sequences of concern (self, task, and impact) were also present when experienced teachers were faced with implementing innovations.

The three stages were expanded into seven dimensions of concerns, which may vary in intensity. Self concerns include three stages. The first is an awareness of the nature of the innovation. This is followed by a need for information. The third stage reflects personal concerns about the innovation. Fuller's task concerns are reflected in the fourth stage, when management of the innovation and implementation issues are priorities. The impact concerns were expanded to three stages. The fifth stage, once the innovation has been implemented, is a concern about the consequences or impact on students. Sixth, is a desire to collaborate with others, in particular, faculty of other departments or schools. The seventh stage is a refocusing of the innovation based on experience. This theory suggests that interventions and staff development should address the specific concerns of the faculty.

The CBAM model has had some application in educational computing at the K-12 level (Campbell, Fein, Scholnick, Schwartz & Frank, 1986; Cicchelli & Baecher, 1985; Wedman, 1986, 1985; Wedman & Heller, 1984; Whiteside & James, 1985-86), and limited application in higher education. Hall (1976) investigated concerns about use of instructional modules by teacher educators and Wedman and Strathe (1985) developed inservice for computer use by education faculty.

Methods

Twenty-six Education faculty at a Northwest university participated in this study. All participants had desktop computers. That teacher preparation program certifies an average of 400 teachers each year. Some faculty were highly experienced computer users, and other were novices. Students in this program also have access to student computer laboratories across campus.

Data Sources

Data were gathered in two ways. First, faculty completed the Stages of Concern About an Innovation Questionnaire [SoCQ] (Hall, George & Rutherford, 1977). Then, participants were interviewed about their most intense concerns. The SoCQ has five statements for each of the seven Stages of Concern that respondents indicate agreement on a 0-7 point Likert scale. The developers recommended interviewing respondents to verify relative intensities of each of the stages.

Data Analysis

For the SoCQ, raw scores for each of the seven sub-scales were tallied and converted to normed percentiles provided with the instrument for each of those seven categories . Averages of the raw scores were also computed for each sub-scale item for the whole faculty as a group and for those who were users of the innovation, and for those who were non-users.

Instructional users were those had actually developed instructional units that incorporated computer-based technologies as part of courses taught. *Non-users* were those who had not yet incorporated any educational computing activities in their courses. This group includes those who may use computers as a personal productivity tool, but had not developed computer related instructional modules; others were only beginning to become familiar with computers. Previous C-BAM studies have indicated that experience with an innovation was an important factor in the interpretation of the stages. Wedman (1986) argued that concerns profiles differed when different parts of "innovation bundles" (i.e., interactive video, computer-assisted instruction, word processing) were considered on different SoCQ scales. Additionally, studies of knowledge growth in the teaching profession indicate that teachers' understandings of how to teach particular topics were altered with experience teaching those topics (Shulman, 1987).

Statements from interview notes were categorized according to the seven concern categories by agreement among three analysts. Lists were compiled and tallied for categories of concern within each of the seven stages.

Results and Discussion

Figure 1 displays a line chart of the average percentiles for the respondents. Table 1 lists the percentile scores for the instsructional users and non-users. Thirteen faculty were classified as users of the innovation. That is, they had incorporated computing activities in courses and thirteen were non-users, who had yet to include computer components in courses. Table 2 displays the distribution of intensities of concerns between the two groups.

Insert Figure 1 and Table 1 & 2 here

SoCQ

Questionnaire data revealed that faculty as a whole had most intense and frequent concerns in the self concern categories of awareness, information, and personal. The most intense stage (27%) was information (percentile=70). However, the most frequent and second most intense stages were awareness (30%; percentile=61) and personal (7%; percentile=62). The lowest intensity of concerns was for management (percentile=48).

The experienced instructional users (*n*=13) had more intense concerns at the impact stages than the inexperienced users. They had the highest intensity for consequences (percentile=69) and refocusing (percentile=68) and lowest for awareness (percentile=42). Four had highest impact concerns (refocusing=2; collaboration=3; consequences=2) and two had highest task (management) concerns. One had a high self concern at the personal level; however, this person also had second highest levels of concern for impact concerns, in particular collaboration and refocusing. In contrast, inexperienced non-users (*n*=13) had the highest intensity for self concerns, particularly for

Figure 1 Stages of Concern

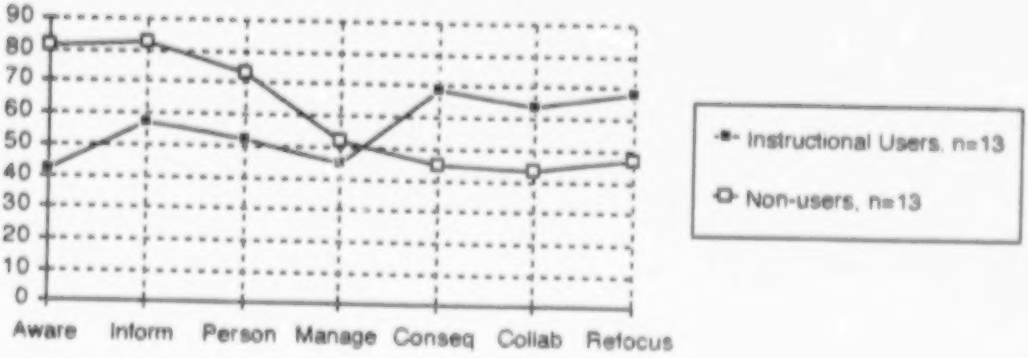

Table 1. **Percentile Means**

Stage	0 Aware	1 Inform	2 Person	3 Manage	4 Conseq	5 Collab	6 Refocus
Instructional Users, *n*=13	42	57	52	45	69	64	68
Non-users, *n*=13	81	83	73	52	45	43	47
Total: All Faculty	61	70	62	48	57	53	58

Table 2. **Distribution of SoCQ Highest Intensity of Concern**

Stage	0 Aware	1 Inform	2 Person	3 Manage	4 Conseq	5 Collab	6 Refocus
Instructional Users, *n*=13	1	1	2	2	2	3	2
Non-users, *n*=13	7	6	0	0	0	0	0
Total: All faculty	8	7	2	2	2	3	2
Percentage	30.7	26.9	7.7	7.7	7.7	11.5	7.7

information (percentile=83) and were least concerned about collaboration (percentile=43). All of the non-users scores revealed highest intensity for awareness and information.

Stages of Concern

Further analysis involved examining the average responses to each of the items on the sub-scales. The following is a discussion of the highest rated item for each of the sub-scales and representative comments of faculty about the most frequently mentioned categories of concern obtained during interviews.

Awareness. Items on the awareness sub-scale indicated two general ideas. One was related to knowledge about the innovation and the other was related to being involved with other issues, instead of the innovation. Among the non-users who had highest awareness concerns were those that did not feel that they were competent computer users as well as those who are more concerned with their own special research interests, rather than technology.

All of the items on this sub-scale were actually rated lowest on the instrument; however, when converted to percentile scores, even a low rating indicates a high intensity. The highest rated item was that of being "completely occupied with other things" (means: all faculty=2.8 on the 0-7 scale; users=1.8; non-users=3.3). One non-user spoke of having too much to teach in his course to "spend a week teaching computers." This person, as well as others, lacked an awareness of ways to facilitate existing course content with computer activities. An experienced user with highest awareness concerns, felt comfortable incorporating computing activities in classes, and was more concerned with educational issues other than technology.

Information. Knowing "what resources are available" was the highest rated statement of this sub-scale (means: all faculty=5.4; users=5.2; non-users=5.6). The most common concern expressed during interviews in the information category was for knowing what software and hardware were available on campus for students to use, as well as kinds of programs being published by software developers. Other concerns were about acquisition of specific resources, such as a movable computer demonstration station with a projection pad. As one person stated, "We can't do it [demonstrate teaching with computers] if we don't have anything [hardware and software]." Concern was also expressed about funding for resources for faculty needs. One experienced instructional user scored highest for this stage and was curious about campus resources.

Personal. The highest rated item on this sub-scale was wanting "to have more information on time and energy commitments required..." (means: all faculty=4.5; users=4.4; non-users=4.6). Respondents indicated "time" as a major factor in learning to use the computer and develop instructional applications.

Management. The highest rated item on this sub-scale was a concern about "inability to manage all the innovation requires (means: all faculty=3.9; users=3.5; non-users=4.1). Details of scheduling computer laboratories and quantities of software were addressed. One respondent was concerned about being able to schedule a classes in laboratories so that students and professor could examine software as a group. Another stated that teacher candidates should use computers with children in actual classrooms rather than only in an education courses.

One interesting result was the rating by non-users of 3.3 for the item "Coordination of tasks and people is taking too much of my time." It would seem that those who had never incorporated computers in their courses were not thinking about coordinating computer activities for courses. It seems more reasonable that they would have marked to "0" ranking, meaning "not relevant."

Consequences. The highest rated item on this sub-scale was concern "about how the innovation affects students" (means: all faculty=5.3; users 6.7; non-users=4.6). Nearly all respondents made a statement expressing the need for candidates to know how to use computers. Non-users emphasized "familiarity;" whereas instructional users emphasized "effective" use of computer activities and had more intense concerns about impact on students.

Collaboration. The highest rated item in this category was for wanting "to coordinate my efforts with others to maximize the innovation's effects" (means: all faculty 4.9; users=5.1; non-users=4.7). This category is for comments about working with other faculty. One comment indicated we should "find out what teachers in the area are doing with computers." Another said: "The faculty needs to agree on what they will actually do in courses." Although this category received the lowest intensity rating by non-users, four of them indicated a willingness to include computer activities if they could get some help in using computers and developing assignments. There was also interest in knowing what other faculties were doing, in particular, public school teachers in the area. One indicated that there ought to be collaboration, but it would be difficult to find the time.

Refocusing. The highest rated item on this sub-scale was about modifying "use of the innovation based on the experiences of our students" (means: all faculty=4.3; users 5.0; non-users 3.4). Dissatisfaction was expressed about the quality of current materials which some felt were inadequate in numbers, failed to represent quality educational software applications, and were not representative of current state of the art. As there was no clear plan for integrating computer activities in courses in this program, several spoke about requiring computer courses or completing of computer activity checklists. Rather than refocus, several addressed the need for developing a focus or plan. There were also comments about which platform(s), i.e., PC, Apple II, Macintosh, that students should be required to use.

Implications

As the SoCQ is generic and applicable to many innovations, this study also provides information about the content of each of the seven stages of concern within the context of educational computing. It further provides an example of the application of CBAM theory in the context of higher education teacher preparation programs. Using Fuller's (1969) developmental framework of self, task, and impact concerns, the faculty as a whole had the most intense as well as most frequent concerns in the self concern categories. It should be emphasized that in many cases, there were only one, two, or three points difference between highest and second high intensity scores. The SoCQ was developed as an instrument to diagnose concerns so that the concerns could be addressed. It was not intended that individuals be labeled or judged on the basis of the responses. Results should be cautiously interpreted as the number of respondents in this study was small as well as being a non-random sample. The innovations that were used for developing the scales and norms appeared to have clearly defined conceptual frameworks, stated procedures, and associated materials for faculties to use. At the time of this study, the innovation was still in the definition and design phase. Therefore, the meaning of the phrase "Integrating Computers in Teacher Education Courses" would have had a much wider interpretation than a more clearly defined innovation. This may be problematical to compare this innovation with innovations on the percentile scales. Further studies of concerns of higher education faculty with clearly defined instructional computing expectations for faculty and students with a history of implementation would be beneficial. In such contexts, determation of the types of impact concerns would be informative in helping maintain implementation of educational computing innovations.

It appears the most important factor influencing intensity of stage of concern was whether or not the respondent had experience incorporating computing assignments in courses. Instructional users tend to have higher levels of intensity for impact concerns. Those with high collaboration and refocusing concerns could help facilitate a plan and work with other faculty needing assistance with developing instructional applications.

Instructional non-users,who may use computers as personal tools but had not included instructional applications in courses, had the highest self concerns. None had most intense concerns beyond information. Overviews and demonstrations of educational computing applications should be provided, perhaps by experienced instructional users, as well as guest speakers. Instructional development assistance should also be provided. It does not seem reasonable to expect that they include computer components without some assistance for this group, who expressed willingness to participate in some way in increasing computing abilities of other faculty and students.

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Title:

Evaluating Interactive Instructional Technologies: A Cognitive Model

Author:

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Introduction

This paper has three main purposes. The first purpose is to analyze the strengths and weaknesses of three prevailing evaluation models, with special attention to the role of feedback (overt or covert) in each paradigm. The second purpose is to present a framework for analyzing issues faced by evaluators of interactive instructional technologies. Finally, the implications of applying this framework to macro-level evaluation of interactive instructional technologies will discussed.

Questions, Questions, Questions

Professionals in the business of affecting human performance cannot escape evaluation. When making program decisions, a systematic process of judging must be used. Compound the pressure of instructional decision-making with ever-changing interactive technology delivery systems, and the inherent problems surrounding evaluation expand into an exponential migraine.

With these problems come a wave of questions. Where do you start? Who are your real clients? How do you decide upon the major questions to structure your study? How do you address hidden agendas? How sufficient are objectives-based evaluations when working with innovative programs? How do you balance quantitative and qualitative data collection methodologies? Sure, it's cheaper than hiring outsiders--but does formative internal evaluation really work? How do you decide the evaluation is complete? Most importantly, after you have conducted this study, how do you feedback your hard-earned evaluation results to critical audiences? Call these professionals what you will-- trainers, instructional designers, course developers, instructional technologists, curriculum planners, teachers, program evaluators--they have not yet reached consensus about how to answer these questions.

Since the late 1960s, authors have addressed the need for systematic program evaluation models. Undoubtedly, the use of models to order educational processes facilitates the conception of problems and the perception of interrelationships within these problem contexts. While each model may view the same set of interrelationships, it is inevitable that certain concerns of the model builders will differ due to personal frames of reference (Alkin, 1968). Dillon (1981) extends this personal dimension of modelling to include "prefabricated configurations of concepts" or "patterns of coherence that we expect to find."

The modeling of social systems involves another potential danger. Education's use of analog models drawn from the "hard" sciences is troublesome to the extent that empirical models represent only "observable" realities. The human dimension in instruction requires models which represent both observable and subjective realities. This dilemma of inherent change is further compounded in evaluation when the evaluator threatens to question existing structures, make covert values visible, and test commonly accepted myths (Tucker & Dempsey, 1991).

In 1971, Daniel Stufflebeam raised several issues of concern to evaluators. These issues have yet to be addressed adequately by prevailing evaluation models. He notes four problems in the application of experimental designs to evaluation. First, selection of experimental designs conflicts with the principle that evaluation should facilitate continuous program improvement. According to a colleague of Stufflebeam, "experimental design prevents rather than promotes changes in the treatments because ... treatments cannot be altered if the data about differences between treatments are to be unequivocal" (Guba, 1969, p. 34). Second, traditional research methodologies are useless for making decisions during the planning and implementation of a project. Rather, the stress on controlling operational variables creates a contrived situation and blocks the collection of natural and dynamic information. Third, the typical research design does not apply to the "septic" conditions of most evaluation contexts. The evaluator is not interested in establishing highly controlled conditions within which universally true knowledge can be generalized. Instead, "one wishes to set up conditions of invited interference from all factors that might ever influence a learning (or whatever) transaction" (Guba, 1969, p. 33). As a final point, internal validity is gained at the expense of external validity. Clearly, equating evaluation models with empirical models is limiting to dynamic program development concerned with credibility, (Lincoln & Guba, 1985), particularly in largely undocumented areas like instructional technology programs.

Diversity of major evaluation models

The current practice of evaluation relies heavily on three models developed over twenty years ago: (1) Tyler's (1942) objectives-based model, (2) the decision-making approaches exemplified by Provus' discrepancy model (1969, 1971) and Stufflebeam's (1983) CIPP model, and (3) values-based approaches such as Stake's responsive schema (1967, 1982) and Scriven's goal-free model (1967, 1972).

Model diversity emerges from the various emphases placed on each of these tasks. Another source of variance is how the evaluator relates to the client system. For example, Pace's (1968) analysis of evaluation models indicates that large, complex, and of longitudinal evaluations may require a different model -- one that considers a broad range of social and educational consequences. Holistic judgments require assessing more than program objectives. Instead, expand the evaluation to question other program dimensions such as expected and unexpected consequences, cultural characteristics of the setting, and the processes of program delivery. Evidence gathered to answer these questions should be both quantitative and qualitative, including the systematic collection of personal perceptions.

There are strengths and weaknesses in each approach which have emerged over the ensuing years. Rather than focus on their well-publicized strengths, the rest of this section will summarize some inconsistencies or areas which have not been addressed by each model. This critique is motivated by the need to understand why evaluation of interactive instructional technology projects has been fraught with difficulties and is often a dissatisfying experience for both the evaluator and the evaluated.

To demonstrate the different emphases placed in various evaluation concerns, Figure 1 compares three prevailing evaluation approaches: Tyler's instructional objectives (IO) model, Stufflebeam's decision- making (DM) approach, and the values-based (VB) approaches of Scriven and Stake. Special attention is given to the following criteria: a systematic methodology which utilizes a combination of quantitative and qualitative data sources to portray a more holistic reality; helpfulness toward program improvement; the evaluator's openness to make values overt and to facilitate the planning of probable futures for a program. The rest of this section analyzes the strengths and weaknesses of each model in more depth.

Insert Figure 1 about here

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1. Instructional Objectives Approaches

Tyler's model has several merits. It provides valid, reliable, and objective data for an evaluation. It allows the evaluator to indicate attained and unattained objectives. On the other hand, strict application of the Tyler Model creates difficulties. It ascertains student outcomes but ignores the contexts and processes that lead to these final outcomes. The statement of objectives in behavioral terms is a long and often tedious procedure which limits sources of evidence to purely quantifiable data. In essence, it is too easy to avoid questions about the worth of the objectives themselves. This is especially true if the evaluation is conducted after the objectives are formulated. When this happens, the evaluation is often limited to making superficial revisions of performance objectives.

In response to these difficulties, more flexible "neo-Tylerian" models have emerged (Taba & Sawin, 1962; Cronbach, 1963; AAAS Commission on Science Education, 1965). Tyler's data sources have been expanded to include observations on teaching method, patterns of classroom interaction, physical facilities, and student motivation. "Neo-Tylerian" ideas have contributed to the field's shift from a terminal focus to one which synthesizes both process and product elements. The emphasis of evaluation is on facilitating instructional improvement. Two major limitations persist. One, the evaluators do not incorporate client feedback into the proposed evaluation. Second, futures planning is neglected.

2. Decision Making Approaches

A second group of evaluation theorists, notably Provus and Stufflebeam, believe the evaluator's task is one of delineating information to be collected, planning a data collection methodology, and helping decision makers use the information collected. It is the responsibility of the decision maker, not the evaluator, to make judgments from this information. Four questions are basic to this approach:

- What should the objectives be?
- How should the program be designed to meet these objectives?
- Is the program design being carried out effectively and efficiently?
- Was the program worth what was invested in it considering the products achieved? (Reasby, 1973, p. 23).

While advancing the field by specifically addressing standards, Provus (1971) identified several weaknesses in his model. He concludes that the major weakness with the discrepancy model seems to stem from failure to understand the limits on institutional behavior set by field conditions, the intricacies of the decision-making process, and the origin and use of criteria in that process. Context evaluation is not addressed and the exhaustive use of behavioral standards may limit the creative, adaptive responsiveness of a program staff. Provus's approach does not clearly identify the type and ultimate use of information to be collected at each stage. The model could also be faulted for being incapable of evaluating rapid, large-scale changes characteristic of early instructional technology projects. Decision-makers are not always rational, yet the model assumes such behavior. Finally, the Discrepancy Model does not address how evaluators are recruited, trained, and maintained in the system.

The Phi Delta Kappan Committee on Evaluation, chaired by Daniel Stufflebeam (1971), has perhaps exerted more influence than any group in attempting to lead the educational profession away from excessive reliance on classical research models. Instead, an evaluation model is offered which assists decision makers in pinpointing their values so that they can best be served by the decisions made. This model, known as CIPP, specifies four types of evaluation: Context, Input, Process, and Product (Stufflebeam, 1983).

Though mechanically total, the CIPP model excludes overt values in its schema. According to Stufflebeam, the evaluator's role is one of collection, organization, and analysis of "relevant" data for "relevant" decision makers. Overt judgment of the intrinsic worth of the program's objectives is not considered by the evaluator or the clients. The entire question of values is kept tacitly in the decision-makers' domain. Another limitation of the CIPP model is its inability to answer two basic questions. How do evaluators and/or clients know which standards are operant? Further, what processes are necessary to enable the decision maker to apply value criteria?

3. Values-Based Approaches

Two major examples of values-based approaches to program evaluation are considered in this paper: Scriven's Goal-Free Model and Stake's responsive schema.

Scriven's (1967; 1972; 1978) Goal-Free model is in definite contrast to those evaluators advocating objectives-based or decision-making approaches. According to Scriven, the distinction between the roles and goals of evaluation are often intentionally blurred. Whatever its role, the goals of evaluation are always the same -- to estimate the merit, worth, or value of the thing being evaluated. Scriven goes on to point out that the subversion of goals to roles is very often a misguided attempt to allay the anxiety of those being evaluated. The consequence of this type of distorted evaluation could be much more undesirable than the anxieties evoked. As an alternative, Scriven (1972) declared that both summative and formative evaluations will increasingly become "goal-free." Scriven stresses the evaluation of actual effects against a profile of demonstrated needs. One of the many roles of the evaluator is to examine the goals of the educational program and judge the worth or value of these goals against some standard of merit. From the data he has collected, the evaluator can determine whether these objectives are being met.

One of the great strengths of this model is addressing the role and values of the evaluator. In spite of the model's strengths, several questions still remain answered. How can a client insure that external evaluators properly judge actual effects of a program, whether planned or not? What standards are there to judge whether a goal-free evaluator is not arbitrary, inept, or unscrupulous in his actions? How does one judge how well a goal-free evaluator has interpreted the "demonstrated needs" of a project?

The theme throughout many of Stake's writings (1967, 1970, 1972, 1973, 1975, 1982) is that an evaluator must do his best to reflect the nature of the program and not focus on what is most easily measured. Furthermore, he writes less about the link between evaluation and decision making than other evaluation theoreticians. Like Scriven, Stake believes that both descriptions and judgments are essential and basic acts of any evaluation and should be combined to portray an educational program. He goes on to describe the role of evaluator as a technician who can provide both relative and absolute judgments. In this respect, Stake takes a more conservative stance than Scriven. Stake (1973) recommends that the evaluator should not take an absolutist position regarding the program's goals because this is likely to make clients less willing to cooperate in the evaluation.

The Stake model exceeds most models in attempting to describe and judge the entire educational enterprise, rather than examining outcomes alone. In terms of process and scope, the Stake model deals more comprehensively with a number of evaluation needs. The assessment of evaluation procedures in the descriptive matrix is unclear as it appears that procedures would be described with transactions. However, procedures are selected prior to the learning experience. An effective method for analyzing the role of values in the program can be found in this model as can a methodology for discovering which values are being served. On the critical side, Stake's approach does not appear to provide for evaluating decision alternatives during the structuring of the learning experience. Furthermore, he does not provide for systematic feedback in program development. While the instructional program is looked at in terms of antecedents, transactions, and outcomes, underlying the whole approach is a perspective that looks at evaluation from the terminus.

Polemics in Program Evaluation

Evaluation is ever present and continues to operate, both overtly and covertly. Furthermore, evaluation is only as good as the environment that the evaluator is able to coalesce and share among all significant players. Approaching this cooperative state can be facilitated by Polanyi's (1962, 1966, 1975, 1978) constructs of collecting multiple perceptions in order to approach a shared reality. He also advocates trying to make tacit perceptions overt rather than being unconsciously controlled by these perceptions, and including extended dwelling in an evaluation to experience more than the surface and first impression phenomena. In essence, out of these diverse perceptions we can identify critical polemics as signposts which expand but do not fix our capability to describe and judge. That is, we can use these polemics to avoid a closed view of evaluation and open our perspective to the variety of factors which can influence evaluator's and client's judgments. Figure 2 summarizes some of these major polemics and their continua.

Insert Figure 2 about here

The Need for a Different Model to Evaluate Instructional Technologies

As summarized in Figure 2, the three prevailing approaches possess similarities and differences. Special attention is directed to the presence or absence of several criteria: (1) using a systematic methodology which combines quantitative and qualitative data sources to portray a more holistic reality; (2) helping toward program improvement; (3) providing evaluator's feedback to make values overt; and (4) facilitating program planning regarding probable futures. To varying degrees, the instructional objectives approach, the decision-making approach, and the values-based approaches all lack methods for systematizing the feedback of both the evaluated and evaluators.

Given the aforementioned variance in evaluation models as well as diversity in clientele and program purposes, it is apparent that judgments about program worth can vary accordingly. It is the contention of this paper that the perceptions of both the evaluated and the evaluators need to be made as overt as possible. This cognitive process will enable the acts of informed judgment making and program improvement. Support for this position has been persuasively advanced by Weckworth:

> "First, there is no one way to do evaluation; second, there is no generic logical structure which will assure a unique 'right' method of choice. Third, evaluation ultimately becomes judgment and will remain so, so long as there is no ultimate criterion for monotonic ordering of priorities; and fourth, the critical element in evaluation is simply: who has the right, i.e., the power, the influence, or the authority to decide." (1969, p. 48).

It is the purpose of this section to offer an interactive evaluation model (Kunkel & Tucker, 1983; Tucker & Dempsey, 1991) which addresses some of the weaknesses of the aforementioned models and strives for credible synthesis of their strengths. This is especially difficult to achieve in contexts reflecting diverse client and audience values such as instructional technology programs. A macro-level evaluation model is therefore perceived as a body of interrelated criteria. These criteria help determine major questions, sources of evidence, and standards for judging the findings and making recommendations. Finally, it is informed by the research base of recent developments in cognitive psychology. Figure 3 summarizes the cognitive complexity of this process as a series of:

- contextually relevant exchanges between information inputs and feedback messages between the evaluation and clients;
- perceptual representations of this data; and
- resultant actions, responses and/or judgments regarding the data.

Insert Figure 3 about here

By making overt the vulnerable judgments of both evaluators and those being evaluated, a synthetic picture of what the evaluation intends to focus on can be negotiated. Through cycles of feedback between the evaluator and clients and negotiation using the feedback information, operative values can be embodied in the major evaluation questions asked. In addition, these values can serve as judgment criteria for decision-making. On the other hand, if the operative values are not known, distortion results in terms of what is questioned, how evidence is gathered, and how judgments are made.

In the model of evaluation proposed, certain value criteria are non-negotiable in the sense that along with accepting the evaluator personally, the primary audience must be made aware of and accept five criteria. That is, the model embodies holism, negotiation, evaluator vulnerability, multiple data sources, and is improvement-oriented and futuristic.

A Cognitivistic Model of Program Evaluation

The proposed model of evaluation relies greatly on developments in cognitive psychology. Cognitivism helps us understand the processes behind two evaluation truisms: "Information is power only in the hands of those who know how to use it" and "Evaluation is only as good as the information it is based upon." It is helpful to view evaluation as a complex activity which involves sequences of: gathering information within situations or contexts, representing this information in idiosyncratic perceptions, and then using this data for some sort of judgment, decision, or action.

Evaluators and decision makers are required to integrate information from many sources when forming an initial judgment, reviewing recommendations, and ultimately making a choice among alternative strategies. The quality of the decision hinges upon how well the rater is able to encode, store, retrieve, and integrate information from these multiple sources into a judgment. Unfortunately, this process is not easy. A piece of information must pass through many filters before it is recorded or retrieved. More than informational, feedback can also serve motivational functions (Kopelman, 1986). It can provide information about the correctness, accuracy and adequacy of the program. It encourages developing, revising, and refining task strategies, thereby laying the foundation for program improvement (Earley, 1988). Not surprisingly, decision makers use only a subset of available information in evaluating a program. In fact, information can delay and complicate decision making for many. When confronted with a problem, the decision maker brings his limited information and limited cognitive strategies and arrives at the best solution possible under the circumstances. Simon (1978) calls this "satisficing."

As described in the next section, research suggests decision-making is both a rational and irrational process. Decision-makers rely upon simplifying strategies or heuristics when judging complex environments. While these strategies can be helpful in avoiding cognitive overload, if applied inappropriately, heuristics can provide a significant source of bias and error in decision outcomes if applied inappropriately. To counter this potential bias, an evaluation model (see Figure 3) is proposed that:

- is interactive and negotiated between the clients, evaluators and participants;
- is based on the perceptions and values of many participants to be capture a holistic rather than positivistic reality;
- involves significant players throughout all four phases, not just at the beginning and the end; and
- systematically uses feedback to serve informational and motivational functions.

Phase 1: Generating Questions and Setting Standards

As depicted in Figure 3, Phase I has two levels of feedback loops. These loops consist of perceptual exchanges between the clients, evaluators and relevant audiences. These exchanges involve the perception of the task demand of the client and major questions synthesized by the evaluator to focus the evaluation.

Consider the first feedback loop. Here, the client introduces the task demand to the evaluator. The client's presentation can be influenced by both overt and covert factors, how stable the client's organizational environment appears to be, prior history of experiences with evaluation, and general belief structures. It becomes readily apparent that evaluation serves many functions besides error reduction. For example, it can provide evidence of the client's competence, signal impending action, and can protect the client politically.

Next, the evaluator perceives the task. This perceptual representation is shaped by a variety of factors. These factors include the evaluator's prior work experiences, his ability to decode semantic and semiotic messages, the perceived priority or strength of demand of the task, recognition of political forces, confidence, and stakeholder boundaries.

The first output of the evaluator is an attempt to identify the program's operational questions and standards expressed by the client. This could be done at any phase of the instructional process (e.g., analysis, design, development, implementation, or dissemination). This completes the first cycle of information inputs.

If an evaluator uses only the first feedback loop to develop his questions and set standards, the risk of perceptual misunderstandings between the evaluator and client are still present. Recognizing this risk, experienced evaluators often confirm their identification of the major questions by seeking feedback from the client. Clients are asked how relevant these questions are to their interests and needs (versus a more research-oriented perspective which would give the evaluator sole authority to determining what is valuable and relevant). Factors which can influence the client's feedback message include: the client's expectations about short and long term program outcomes, the personal significance of the questions, penalty costs of whether or not to gather the information, the client's perception of the evaluator's degree of expertise, and rapport established between the client and evaluator.

When feedback is readily available, the risk of serious initial judgment errors is not as high because feedback provides information upon which to base corrective adjustments. Consider Hogarth's (1981) likening this process to aiming at a target. The evaluator may engage in a series of exchanges with the client. The intent of these exchanges is to focus the evaluator's perception of the task or "target." Then the evaluator forms a mental representation of the perception. For example, in the first phase of evaluation, this representation serves to eliminate, substitute, or strengthen the evaluator's perceptions about the questions being asked. For example, perceptions of any hidden agendas emerging from the first cycle of information inputs are considered. Given the prior experience of the evaluator, the task may be encoded as objectives-based, management-based, or values-based, or a composite of all three.

Finally, this cycle ends with the evaluator negotiating an evaluation plan. This plan or paradigm serves as a blueprint to guide the ensuing evaluation. Three components make up this paradigm: questions, evidence, and standards. Questions to guide the study are framed, potential sources of evidence clarified, and standards or qualities by which to judge the findings are made overt. Negotiation of the paradigm allows for the systematic participation of all relevant stakeholders. This negotiation should be done during the first phase of the evaluation, thereby reducing some of the perceptual errors inherent in models such as Scriven's goal-free approach. It has been the experience of the author that negotiation serves as the first step in co-opting even the most negative stakeholders. This is accomplished by being open to their critical questions and emerging perceptions.

Implications of Phase 1

Helping stakeholders generate questions is affected by one's capacity and motivation to generate alternative hypotheses for a given question. (For more thorough discussions of hypothesis generation refer to the work of Higgins & King, 1981; Eco and Sebeok, 1983; Fisher, Gettys, Maming, Mehle, & Boca, 1983; Mayseless & Kruglanski, 1987.) For example, in situations where time pressures are great, a client or evaluator may be tempted to focus solely on addressing pre-defined objectives. In settings where formative evaluation provides useful feedback for product development and revision, its design is often constrained by available resources such as time, money, personnel, and facilities.

Extending the example of formative evaluation to interactive instructional technology further, it appears that two major questions are posed. One deals with the content and technical quality of the product and the other deals with its learnability within authentic contexts. More specific questions generated by these two foci could deal with product initiation, design, content development, media development, production, testing and maintenance (Foshay, 1984). Geis (1987) suggests that feedback is needed regarding the content and sequencing of instructional events as well as the nature of learner control of the content or message as sent. Consider the case of instructional hypermedia. Table 1 summarizes just some of the questions that could emerge when one is open to more holistic views of evaluation, hopefully more accurately reflecting the medium's true nature.

Insert Table 1 about here

Besides these two major questions, each stakeholder appears to have idiosyncratic questions of interest. Rather than reaching consensus on the questions, an effort is made to solicit the complete realm of questions and then synthesize them into broad questions which allow multiple perspectives. Fifteen years of evaluation field narratives suggest this is a viable strategy and management research seems to support this as well. The research of Walsh and associates (1988) argues that increased coverage and decreased consensus are important early in the decision making process to help define the problem or task. Once the group comes to understand the information environment, however, a consensus around a narrower view (i.e., evaluation paradigm negotiated during feedback loop 2) is beneficial. The ability to read a decision environment and capture the major evaluation questions and the belief structures behind these questions is the essence of shared veridicality.

Questions are also influenced by an individual's capacity to see the values or standards that are behind the questions. Why was the question asked in the first place? Standards describe the results that are desired or should be achieved upon satisfaction of a task. To facilitate performance, researchers contend that standards need to be specific as well as identify qualities and quantities of output expected (Baird, 1986). Specific standards serve as motivational devices for individual performance (Locke et al., 1981; Taylor, 1983) and can anchor future decisions of the client (Huber & Neale, 1986). This phenomenon may explain the evolution of "building block" evaluations which focus on lower level, fragmented tasks which are more easily identified and documented.

Instructional designers lack consistent formative evaluation guidelines regarding products that aim at interactive, integrative skill development. It is difficult (but not impossible) to evaluate situations which allow learners to practice multiple skills. Compounding this complexity is the presence of unpredictable navigational paths and a need to assess variable performance standards. In fact, interactive instructional design seems fraught with many aversive prior learning experiences. For starters, many managers expect cost overruns and schedule slippage. Another fear involves the losses attributed to the new product's possible failure spreading to established products. Finally, while many designers recognize that prevailing linear and iterative strategies result in "piecemeal" products, they lack alternative design methods peculiar to this technology.

Program and product performance is compared to a norm or standard. Usually, the norm is the maximum achieved by an optimal allocation policy. Invariably, performance is found wanting (Busemeyer, Swenson, & Lazarte, 1986). Optimal policies cannot be specified without perfect knowledge of the goal state. For many real decisions, however, only imperfect and vague information about the objective and solution is available. Even if specifications exist, management may not have made it clear whether the intent is to meet specifications or exceed them. Hence, there is a perceived need for evaluation. This seems to be particularly true of interactive technologies such as instructional hypermedia where the operant criteria have yet to be defined.

And what happens when the product's instructional and business goals are not clearly communicated to the technicians and instructional designers? What often results is loyalty to functional standards versus the total plan because immediate functional rewards upstage measures of organizational performance. For example, in university environments where product development is almost exclusively driven by external funding, the product can have high priority within the grant but low priority throughout the rest of the institution.

Standards are often very difficult to calculate, and it seems unreasonable to expect that the typical client knows the optimal solution a priori. For example, developers' and users' judgment of product quality extends beyond hardware and software. Quality involves technical, educational, and financial attributes; installation issues; low maintenance; high reliability; compatibility with other equipment already in place; ease of upgrading; and multi-platform access. These are standards that are typically not incorporated into questions asked by developers. However, it is reasonable to expect that program managers and designers can improve their standards and rules for optimal policies iftraining incorporates informative feedback (Busemeyer, Swenson & Lazarte, 1986). And the corollary is that while this rational explanation may be possible, the evaluators must be prepared for instances where the client intends the evaluation to serve functions other than an error reducing role. For example, clients may want the evaluation to give evidence of a key player's competence, signal impending action, or "cover their tracks."

Expectations about future outcomes strongly affect one's decisions (Abelson & Levi, 1985; Feather, 1982). Developers often devote much time examining the implications of alternative designs and the adequacy of the likely reward in view of the risks incurred. Because of the importance of such expectations, much research has been devoted to understanding how individuals estimate probabilities of future events. Evidence has accumulated that individuals use a general cognitive strategy, the "availability heuristic" (Tversky & Kahneman, 1973). In using this heuristic, individuals estimate the probability of events by the ease with which they can recall or cognitively construct relevant instances. Specifically, questions can serve as a valuable heuristic or cognitively simplifying strategy for participants in the evaluation process.

Not surprisingly, our field experience indicates that decision makers use only a subset of available information in evaluating a program. Rather, managers seem to rely on heuristics to simplify complex environments. While serving to avoid information overload, inappropriately applied heuristics can provide a significant source of bias and error for decision outcomes. For instance, people seem inclined to overweigh certainty in their decisions (Kahneman & Tversky, 1979). As evaluators, we should anticipate this heuristic when clients generate evaluation questions--and strive for questions that capture the task's complexity rather than satisfy predetermined decision-making. The systematic use of shared cognitive feedback and negotiation to "cleanse" the questions is seen as an effective strategy to minimize this bias.

Finally, framing a question can lead to a perceptual bias which may potentially be elicited by either task or context characteristics. Kahneman and Tversky (1979) suggest that decision makers treat the prospect of gains much differently than the prospect of losses. Often, whether the decision maker is evaluating the prospect of gains or losses is simply a matter of the way a question is presented or phrased. Thus, the way questions as well as findings are framed (in terms of losses or gains) can influence decision makers' risk propensity and thereby their decisions (Bazerman, Magliozzi & Neale, 1985; Huber & Neale, 1986; Neale & Bazerman, 1985).

Phase 2: Description of Data Sources and Analysis of Alternatives

The quality of the ultimate choices made hinges upon how well the clients and evaluators are able to attend to, encode, store, retrieve, and integrate information from multiple sources into a judgment. Ilgen, Fisher, and Taylor (1979) identified the information source as a particularly critical determinant of information utilization. They go on to warn that individual differences often influence information receptivity, credibility, and use.

Unfortunately, this process is not easy. A piece of information must pass through many filters before it is recorded or retrieved. Decision makers have a propensity to use only a subset of available information when judging a program's worth. This irregular (and often irrational) process may be more systematic if feedback loops are used. This loop or cycle consists of: (1) information inputs; (2) perceptual representations; and (3) outputs regarding the evidence gathered to answer the questions posed in phase one. Two feedback loops appear to operate during this second phase.

In the first feedback loop in this phase, the evaluator collects data. This process is affected by: the stability of the organizational environment; the length of the time the evaluation has committed to dwelling in the system; and the nature of the balance between qualitative and quantitative evidence. Acquiring information prior to a decision has two major risks. First, a tenuous evaluator could overacquire information and incur excessive costs. Second, an overconfident evaluator might underacquire information and incur excessive risks of decisional error. In any event, the costs of gathering additional information may be immediate and easy to estimate, but the benefits of doing so can be unclear and often long delayed (Connolly & Thorn, 1987).

Next, the evaluator analyzes the obtained data. This representation is affected by a myriad of factors such as: the evaluator's information load capacity; his audience analysis; the amount of anticipated versus unanticipated information revealed; audience and client analysis; and whether a compensatory or noncompensatory data synthesis model is being used (Einhorn & Hogarth, 1981; Billings & Marcus, 1983). Noncompensatory models minimize the questions, criticisms and divergent data. Compensatory models allow the representation of cognitively complex and sophisticated strategies for information integration.

After the data receives its initial analysis, the evaluator reports initial data findings to the client. This reporting procedure must consider many factors. Some crucial variables include: the amount of feedback processing time available to the client; the client's relative emphasis on program documentation versus program improvement; and whether the evidence can be shared with the clientele all at one time or presented over a period of time.

Perceptual errors can result if the evaluator does not receive a message from the client regarding the accuracy of this initial data report. By scheduling a regular exchanges, the client's initial certitude about the original evaluation plan (as well as hidden agendas) can be ascertained. In the process, a sort of error checking occurs about the perceived accuracy of the data thus far collected as well as an early measuring of the evaluator's credibility. This is also the time to assess the client's tunnel vision and blind spots and selective perception.

The evaluator cognitively represents the client's messages in light of commitments (sometimes complementary and sometimes competing) between the client and evaluator. This representation takes the form of either improving or simply documenting the program. A choice point also involves the balance between qualitative and quantitative data. Obviously, this takes skill in balancing positive and negative information. This perceptual recycling of data perceptions is necessary in light of research showing human information acquisition is often weakly guided by normative, cost-minimizing considerations. This occurs even when serious efforts are made to simplify the task, provide high motivation and focus attention on balancing information costs and benefits. Clients consistently underpurchase "good" information and "bad" information is consistently overpurchased. One part of the explanation is client difficulty in discerning the validity of different information sources, even after repeated exposure. Another possible explanation is the certainty of the cost involved in acquiring information as against the uncertainty of its benefits in reducing decision errors. A risk adverse client will tend to overpurchase, a risk seeker to underpurchase.

Finally, the evaluator edits the initial data analysis and reports the revisions along with the implications of preliminary judgments given the evidence. Once again, influencing variables include the amount of time available to the evaluation for information feedback to the client, the kind of heuristics which accompany the data, the way information is "framed", and the form of information display.

Implications of Phase 2

Let's continue the example of formative evaluation of interactive technology products and/or projects. The actual process of data collection can generate as many questions as it answers. Just consider the following issues:

- How continuously should data collection be conducted: during rapid prototyping, draft form testing, final testing, or during each stage of the developmental process?
- What qualitative and quantitative methods should be used: self-evaluation, expert review or student review (Montague et. al., 1983); try-out and revision testing sessions (Geis, Burt, & Weston 1985); draft and revise and field-test (Dick & Carey, 1985); one-to-one testing; group testing; extended testing (Stolovitch, 1982; Komoski & Woodward, 1985); peer debriefing; triangulation; negative case analysis; and/or audit checks?
- Who should be included as data sources: learners (expert versus novice), developers, subject area experts, teachers and trainers, native informants, audience specialists, gatekeepers, sponsors, former learners, editors?
- How many people should be involved--what is an "adequate" size?
- What are desirable characteristics of the data sources: representative versus select (e.g., highly verbal or high aptitude), active versus passive, internal versus external to project, continuous versus one-time involvement?
- Where should data be collected: in-house versus field, using simplified versus progressively more complex and less familiar systems?

- When should data collection stop? For example, should evaluation continue until redundancy of learner comments occurs? When is the criterion performance level reached?

The client may accept the evidence "as is", request additional evidence, or even seek to reject the evaluation. For example, the use of user feedback in instructional materials development tends to be supported in research (Baker, 1974; Andrews & Goodson, 1980; Stolovich, 1982; Wager, 1983; Weston, 1986). In general, there does not seem to be an indication that one method of gathering feedback is superior to another. Rather, findings suggest that materials that have undergone formative evaluation with users were superior to original versions. While there is agreement that user feedback promotes product improvement, few clear guidelines exist regarding how to build this feedback systematically into the development process.

Knowledge of client expectations *and* behavioral characteristics are essential for evaluators when gauging the receptivity to their activities and ultimately to the information gathered. Available research in this area suggest that decision makers are:

- only weakly responsive to various normative considerations such as information quality and cost (Pitz, 1968; Wendt, 1969);
- substantially responsive to normatively irrelevant factors such as total information available (Levine, Samet & Brahlek, 1975);
- slow to show learning in repeated decision situations (Lanzeta & Kanaref, 1962; Wallsten, 1968; Busemeyer, 1985); and
- not consistent in their need for either overpurchasing or underpurchasing information (Pitz et. al., 1969; Hershman & Levine, 1970) though risk seekers show a tendency to underpurchase information.

A two tiered approach to data sharing is important for both cognitive and political reasons. The data is most likely to be heard and used by clients if they believe it is true and has utility. This satisfaction index seems to rise when client perceptions about data accuracy is sought before presenting data of a judgmental nature. Additionally, the form of information display can encourage or discourage certain methods of cognitive processing, given the propensity of humans to adopt strategies which minimize their effort. For example, organizing data into a table makes quantitative information easier to use, increasing its impact upon choices (Russo, 1977). Similarly, when data is described in words instead of numbers, decision-makers abandon strategies which use mental arithmetic (Huber, 1980). As Slovic (1966;1975) indicated, the more effort required, the more likely it is that clients will ignore or misuse information. Cognitive strain may cause decision-makers to resort to simplifying strategies or heuristics, many of which lead to biased responses such as preference reversals and violations of transivity. They take information as presented and change the strategy to suit the display rather than transform the data to fit the strategy. When evaluators recognize this process and the impact of framing, they can design evaluation data displays which passively encourage better information processing (Levin et.al., 1985).

Consider Snyder and Swann's (1978) proposal that in the testing of questions and hypotheses (about themselves or other people or events), people predominantly seek to confirm their pre-existing notions. This implies a pervasive insensitivity to disconfirming evidence, and (presumably) a reluctance to generate alternatives. The implications for how evaluators can share information with clients are profound.

Phase 3: Making Judgments

Many evaluators neglect to address their role in the act of judging, preferring to perceive themselves as untainted by values issues. This is counterintuitive. Judgment pervades the total process, from the selection of questions and data sources to the ultimate decisions reached and choices made. Phase 3 presents a series of informational inputs, perceptual representations, and actions in order to generate judgments about program worth.

After receiving the evaluator's final descriptions, data analyses, and tentative alternatives, the client reacts in the form of another feedback message. The nature of this feedback will be tempered by the client's perceptions of certitude about the findings and expected gains versus losses. Many researchers are pessimistic about managers' abilities to interpret information from complex environments accurately. Managers are thought to suffer from selective perception (Dearborn & Simon, 1958), strategic myopia (Lorsch, 1985), tunnel vision (Mason & Mitroff, 1981), and blind spots (Murray, 1978).

Given the client's reactions, the evaluator itemizes and begins to edit the pool of possible alternatives in preparation for generating judgments. Variables that seem to influence this editing process include the evaluator's capacity to visualize a continuum of concrete and abstract instances, the duration of events, and the client's self-efficacy status.

Editing results in the evaluator rating or valuing alternatives against the standards specified in Phase One. Besides the amount of processing time available for the evaluation, what is at stake is the quality of the alternatives envisioned as well as the heuristics used for conveying these alternatives to the client (for example, availability, adjustment, anchoring, and representativeness).

It appears that some decision strategies are used more than others. The issue is frequency of use rather than effectiveness of stategy. Recent research suggests expectation models over-intellectualize the cognitive processes people use when choosing alternative actions (Schwab, Olian-Gottlieb, & Heneman, 1979; Fischhoff, Goitein, & Shapira, 1983; Mitchell & Beach, 1990). For example, formal analytic strategies are seldom used even by people who know about them. Isenberg (1984) adds that even when they use these logical strategies they seldom accept the results that run counter to their intuition. In certain cases, intuition turns out to be more accurate than analytic strategies (Hammond, Hamm, Grassia, & Pearson, 1987). Mitchell and Beach (1990, p.3) capture this concept well with the following statement: "Formal analytic strategies require a great deal of concentration, time, effort, and skill and very few decisions are worth all that. Moreover, for even very important decisions the formal strategies often seem too coldly intellectual".

Observations of professional decision makers engaged with on-the-job decisions suggests that few decisions involve explicit balancing of costs and benefits, let alone the use of behavioristic probability models (Peters, 1979). Mintzberg (1975) reported that most decisions involved only one option rather than many options. The decision was whether to go with that option rather than a choice among competing options.

Simultaneously, the evaluator and the client develop judgments. Their ability to form sound information-based judgments appears to be grounded upon many factors, including:

- ability to reason on three levels: deductively, inductively and abductively;
- ability to manipulate overt and covert information normatively and heuristically;
- ability to negotiate or at least share perceptions;
- clarity of expectations, both internal and external; and
- amount of cognitive dissonance and uncertainty of the decision to be reached.

Out of the judgments represented in the prior step, the evaluator synthesizes a delivery strategy and accompanying recommendations. Besides dealing with the standard variables of determining the timing, written and/or oral formats, and the framing of the delivery matrix, the evaluator needs to weigh the impact of priming. Priming is a process through which particular information becomes activated or more readily accessible to recall (Wyer & Srull, 1980). Priming has been found to impact the type of action plan developed by an individual. In fact, those individuals who were faced with pressures imposed by a difficult goal relied more heavily on the plan they had been provided than those with more general goals (Earley & Perry, 1987). Furthermore, recommendations are more likely to be maintained if the outcomes are positive and more likely to be changed if the outcomes are posed negatively.

Implications of Phase 3

Given the fact that decision makers are required to integrate information from numerous sources when forming a judgment, the quality of the resultant judgments relies on the value each stakeholder places on this information. For example, Foshay (1984) suggests three criteria of interest to training vendors:

- cost-effectiveness (such as reliability and validity of measurement, return on investment, corporate reputation, and contractual expectations for project);
- compatibility with project management system in terms of yielding timely, useful project status information and impacting employee morale and productivity;
- compatibility with the design system such as generating information specific to design and development decisions.

While the research base is limited, our experience suggests that clients judge situations as instances of types with which they are familiar (pattern recognition). They tend to respond best where their own prior successful solutions are presented as the recommended strategies. This can be a problem when trying to enhance an already effective operation with a novel strategy. In addition, there seems to be a difference in whether the "client" making the judgments is an individual or a collective. Fischhoff et. al. (1983) suggest that while individual clients may adapt to recommendations and judgments that will further their gains more easily than their losses, a group of clients is influenced by social consensus. Team members who have been recently successful are more responsive to the needs of others and are less likely to make independently serving judgments.

Self-esteem seems to be a related variable as well. Recent research (Weiss & Knight, 1980; Knight & Nadel, 1986) suggests low esteem people gather more information about possible solutions before implementation and perform better on tasks where the one best solution must be identified (i.e., optimizing). High self-esteem people seem to search for less information before trying a solution, performing better on tasks with obvious solutions, strict time constraints, or where information search is costly. Knight and Nadel (1986) suggest that high self-esteem managers would be less likely than managers low in self-esteem to experiment with new policies or solutions when confronted with negative performance feedback.

While Fischhoff's findings bode well for cohesive teams, many interactive development projects consist of several (sometimes competing) teams. This specialization can give rise to functional managers who begin to insist on making all decisions pertaining to their respective stages and inputs from other teams are not welcomed. The longer the development cycle, the greater the possibility of communication rifts. A compounding problem concerns accountability and receptivity to evaluation feedback in competing environments. If functional managers know they will be held accountable for anything that goes wrong, there is a tendency to hold up work on the new product pending written notice (Foshay, 1984). This sign-off process can dramatically affect the openness to risk taking.

People's cognitive representation of judgmental tasks may conceive of "probabilities" as indices of belief intensity rather than as ratios of favorable chances (Cohen, 1982). They also might conceive of events as nonrandom (Cohen, 1982) and fail to take into account all the potentially relevant information or all the potentially relevant alternatives (Hintikka & Hintikka, 1983). It appears that the motivation to respond to judgmental questions may be affected by at least two needs: the need for cognitive structure and the fear of invalidity. Preliminary research by Mayseless and Kruglanski (1987) suggests that revision of judgments might be slower under a high fear of invalidity but faster under a high need for structure. "In short, fear of invalidity might induce a tendency to be conservative, whereas need for structure might induce a tendency to be excessive" (p. 180). For example, in novel, open-ended environments such as instructional hypermedia projects, designers may often experience an acute need for guiding structure to which they might respond by adopting inappropriately high levels of self-assurance and a closed-mindedness to alternative points of view.

This heightened need for cognitive structure is assumed to promote an early closure to a solution or "cognitive freezing" (Freund, Kruglanski & Schpitzajzen, 1985). For evaluators, this suggests the many risks inherent in how early to give client feedback as well as the nature of the information's significance. Get to know your client cognitively!

But there are risks for evaluators as well. For example, high structure evaluators who rely on checklists for interactive instructional materials revision risk neglecting some critical components since little prescriptive documentation exists at this juncture. It seems more defensible to involve a diverse set of leaders and opinion makers as reviewers if the goal is to trend acceptance of materials. There is still little to guide us in deciding how to choose experts (as well as evaluators) and how to guide their task or structure their output (Geis, 1987).

A person with a high need for cognitive structure is likely to inhibit the generation of competing alternatives to a given recommendation as such alternatives might appear to threaten his existing schema. Previous research manipulating the need for structure in such ways found that individuals in which this need was aroused tended to base their judgments more on (1) early information, rejecting subsequent data, thereby exhibiting "primacy effects", and (2) on pre-existing stereotypes, in this sense being theory rather than data driven. Furthermore, high versus low "need for structure" individuals tended more to seek comparison with similarly minded others likely to support their views and opinions (Mayseless & Kruglanski, 1987). High "need for structure" individuals were characterized by: higher initial confidence in their judgment; more confidence in early information provided by the search; fewer requests for information; and high final confidence in their judgment.

Functionally opposite to the need for structure is the fear of invalidity. This motivation has to do with the desire to avoid mistakes in judgment in terms of their perceived costliness. Where high need for structure promotes a freezing of the judgmental process, fear of invalidity may often promote unfreezing. That is, an increased tendency to respond positively to alternative solutions to the existing situation and/or an increased sensitivity to information inconsistent with the prevailing order and negative feedback. Previous research manipulating the fear of invalidity found that high fear of invalidity individuals suppressed the magnitude of primacy effects. Instead, they had a tendency to translate stereotypes into discriminatory judgments (Kruglanski & Freund, 1983). High fear of invalidity individuals had lower initial confidence, less confidence in early information, requested more information, and had higher final confidence. Overall, fear of invalidity might induce a tendency to be conservative.

Priming constraints are not to be ignored (Tversky & Kahneman, 1981). For example, when presenting negative feedback, about the effectiveness of interactive technology in a training program, individuals who are provided with negatively framed recommendations (i.e., taking an action to prevent losses) are more open to questioning the status quo and consider risky alternative strategies while those provided with positively framed recommendations (judgments to protect gains) are more likely to choose safer, more predictable outcomes. Individuals who have experienced recent losses are more likely to accept informative feedback and are more open to risky alternatives than usual (Fischhoff & Beyth Marom, 1983; Fischhoff, Goitein, & Shapira, 1983).

Finally, little research has been conducted concerning the effects of standards on client and evaluator judgment. It seems plausible that standards might anchor rater judgments by providing a natural starting point against which to evaluate performance outcomes. It also seems logical that performance-based priorities (weighting) would simplify the rating process (Naylor, Ilgen, & Pritchard, 1980) but would exacerbate anchoring effects for low priority standards. Consequently, the validity of performance ratings would be highest when standards are specific and highly weighted (Neale, Huber & Northcraft, 1987). Results of the Neale et. al. study suggest that performance standards do not influence raters' performance related judgments. As they suggest, it would be instructive to test whether evaluators and clients are capable of incorporating differential weighting into their appraisal judgments.

Finally, the recent work on image theory (Beach & Mitchell, 1987; Mitchell & Beach, 1990) seems very promising, particularly the compatibility test. The notion is that intuitive, automatic decision making (and even some deliberative decision making) relies on a simple comparison of each alternative of interest with a limited set of relevant standards called images. Images serve as informational representations and consist of: (1) value images such as the decision makers' ethics, imperatives, and vision of what is appropriate; (2) trajectory images such as future aspirations, goals, and agendas; and (3) strategic images such as plans, tactics and forecasts used to attain the desired goals. If a decision alternative is incompatible with these images, it is rejected. If it is not incompatible, it is accepted as the final decision or as one of the alternatives that is passed on to a more complex mechanism that selects the best among them. The concept of image seems to be related to cognitivists "schemata" and "scripts" (Graesser, Woll, Kowalski, & Smith, 1980; Anderson, 1983) and control theory's "template" (Lord & Hanges, 1987).

Phase 4: Arriving at Decisions and Choices

The final phase of this evaluation model deals with decision and choice mechanisms. Decisions consist of presenting clients with alternatives packaged in a certain form, such as a set of outcomes and probabilities. After searching a perceptual representation of options, the decision maker edits and evaluates these alternatives. Alternatives are compared with each other by rationally calculating the degree of preference or using intuitive tests of compatibility and profitability. Choosing the "best" alternative involves strategies such as elimination by aspects (Tversky, 1972) and prospect theory (Kahneman & Tversky, 1979) and profitability test (Mitchell & Beach, 1990). In addition, affective variables such as mood and the context of the alternatives of a choice can be important in making decisions. As discussed earlier, we know that people tend to avoid risk when alternatives are gains and seek risks when alternatives are losses.

The context in which decisions occur appears to give them meaning. In addition, past successess and failures in similar contexts seems to provide guidance about what to do about the current decision. If the current decision is virtually identical to a past decision stored in memory, it is considered to be recognized and automatic (Beach, 1964). Framing results when the contexts of prior similar decision memories are used to go beyond the information that is presented by the current situation alone and interpret new contexts. Thus, we might expect that manipulating the framing process could have a significant effect on decision making and choosing a final behavior (Rachlin, 1989). In novel contexts where the exceptional is encountered, it seems that the process becomes much less automatic.

The decision mechanism is influenced by whether the client is a novice decision-maker or expert, whether the decision environment is self-initiated by the client or imposed from above or pressured from below and the degree to which the client is risk-taking or risk-seeking. The selection among decision strategies is often seen as a tradeoff between the amount of cognitive resources (effort) required to use each strategy and the ability of each strategy to produce an "accurate" effect (Beach & Mitchell, 1978; Johnson & Payne, 1985; Russo & Dosher, 1983).

The choice mechanism is an outgrowth of the decision mechanism. Its efficiency is contingent upon: the client's perceived self-efficacy; the environmental demands of the client's situation; the attractiveness of the alternatives and incentives for change; past expenditures of effort; short and long term performance valences; and the type of delivery strategy required by the decision.

Finally, the outcome and implementation of the ultimate choice results. As can be seen by the prior sequences, decision and choice are complex, cognitive operations of which evaluators must be more cognizant if genuine implementation of evaluation findings and recommendations is desired.

Implications of Phase 4

Two major types of decision strategies described in the literature are compensatory and noncompensatory models. Compensatory models represent cognitively complex and sophisticated strategies for information integration (Einhorn & Hogarth, 1981) which are indicated by the absence of the interactive use of cues (Billings & Marcus, 1983). Noncompensatory models are indicated by the interactive use of information cues in which a low score on one dimension cannot be compensated by a high score on another dimension (Billings & Marcus, 1983).

Compensatory strategies refer to either the linear model or the additive difference model. The linear model assumes that each dimension for a decision alternative is given a value for each alternative. Comparisons among alternatives are then based on these overall values and the alternative with the greatest value is selected. The additive difference model implies that decision makers compare alternatives on each dimension and then summing differences between dimensions. The summation of differences results in a preference for one decision alternative (Olshavsky, 1979). With both linear and additive difference models, a high value on one dimension "compensates" or counteracts low value on another dimension for the same decision alternative. Noncompensatory strategies involve the use of simplifying rules to reduce to complexity of the decision. The major noncompensatory models identified by Payne (1976) and others include conjunctive, disjunctive, lexicographic, and elimination by aspects strategies.

Frequently, clients must make choices under less than ideal conditions. Uncertainty results when people have incomplete information about the task and doubt is typically generated in a crisis situation when time is restricted for decision-making and there are unanticipated choice points have been presented. Increasing uncertainty is often associated with a decentralization of an organization's communication structure (Tushman, 1979) while increasing the threat often leads to a centralization of structure (Staw, Sandelands & Dutton, 1981). Consider the wide variety of organizations where interactive instructional technology is being created, from an individual's home to large scale multinational corporations and how the nature of this environment can significantly affect the receptivity to make choices revealed by an evaluation.

A related factor appears to be the complexity of the task. Decentralized structures were found to be more efficient and resulted in fewer decision errors for complex and uncertain tasks (Shaw, 1981). Faucheaux & Mackenzie (1966) found that groups performing simple tasks evolved toward a centralized structure while those performing complex tasks did not. Recent researchers have generally supported these findings but caution that the relationship between uncertainty and structure is a complicated one that depends on additional factors such as the quality of information a client receives from individuals versus groups, insiders and outsiders like contracted evaluators, the skill of its leaders, and the particular sources of uncertainty (Argote, 1982; Fry & Slocum, 1984; Schoonhoven, 1981; Argote, Devades, & Melone, 1990).

This tendency toward centralization can be dysfunctional given centralized structures perform more poorly than decentralized structures for complex and uncertain tasks (Snadowsky, 1972). This appears to occur because members at the hub of centralized networks experience overload under high uncertainty conditions and centralized structures are very vulnerable to this increased overload. As more group members perceive that the information needed to reach a decision and make a choice resides throughout the group rather than one member, we expect decentralized structures to emerge. While this projection is fascinating to contemplate, it is anticipated that it will occur with much discomfort and resistance.

Four basic mediator strategies which have implications for evaluators: press, compensate, integrate and inaction (Carnevale and Conlon, 1988). Press refers to efforts to reduce disputant stakeholders' aspirations and occurs when evaluation mediators do not value client aspirations and they perceive that there is little common ground. Compensation deals with efforts to entice client disputants into agreement. For example, this occurs when evaluators value each stakeholder's aspirations, agreement appears likely, and there is little chance that integrating will be successful. Integration occurs when there are efforts to discover options that satisfy the disputants' aspirations or when mediating evaluators value parties' aspirations and perceive that there is common ground. Integration is used when there is a good chance of achieving a mutually acceptable solution. A final choice is inaction by which the mediating evaluation lets the parties handle the dispute on their own.

Summary

The systematic combination of evaluation and cognitive processes can guide the decision maker in a direction that continuously improves his or her performance. To varying degrees, the instructional objectives approach, the decision-making approach, and the values-based approaches all lack consistent methods for systematizing the perceptions of both the evaluated and evaluators. This paper has presented an alternative evaluation framework consisting of four sequential phases: (1) negotiating a paradigm to focus the evaluation and specify major questions, sources of evidence, and standards by which to judge the findings; (2) collecting and analyzing data sources and reporting the emerging implications of various alternatives; (3) judging the alternatives and synthesizing a delivery matrix of recommendations; (4) helping the client process decision and choice mechanisms instrumental in delivering an improved program.

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Figure 1. Summary of criteria for three evaluation models: objectives-based (OB), decision-based (DB), and values-based (VB)

MODEL CRITERIA	OB	DB	VB
1. intended outcomes documented	•	•	•
2. unintended outcomes documented		x	•
3. document contexts leading to outcomes		•	•
4. document processes leading to outcomes		•	•
5. client standards overt		•	•
6. evaluator standards overt			•
7. client-evaluator negotiation			
8. program improvement-oriented			•
9. hard & soft data balanced			

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key: • denotes criterion being met in a model

x denotes criterion being inconsistently met in model

Figure 2. Polemics of an Evaluation

Questions: To what degree should they be...

1. ( ) ( ) ( ) ( ) ( )
client helpful — field helpful

2. ( ) ( ) ( ) ( ) ( )
formative — summative

3. ( ) ( ) ( ) ( ) ( )
objectives-based — holistic-based

4. ( ) ( ) ( ) ( ) ( )
independent — negotiated

Sources: To what degree should they be...

5. ( ) ( ) ( ) ( ) ( )
descriptive — judgmental

6. ( ) ( ) ( ) ( ) ( )
quantitative — qualitative

7. ( ) ( ) ( ) ( ) ( )
in-dwelling — one-shot

8. ( ) ( ) ( ) ( ) ( )
deductive — abductive — inductive

Standards: To what degree should they be...

9. ( ) ( ) ( ) ( ) ( )
tacit — overt

10. ( ) ( ) ( ) ( ) ( )
proactive — reactive

11. ( ) ( ) ( ) ( ) ( )
self-initiated/internal — imposed/external

12. ( ) ( ) ( ) ( ) ( )
elitist or parochial — subordinate

Figure 3: 4 phase chart

FIGURE 3

INPUTS WITHIN CONTEXTS	PROCESSES	OUTPUTS
PHASE 1: QUESTIONS		
INFORMATION	PERCEPTUAL REPRESENTATION	ACTION, RESPONSE, AND/OR JUDGMENT
1. Client's Task Demand • surface and depth factors • stable vs unstable contexts • past performance of clients • client belief structures	**2. Evaluator's Perceived Task** • prior experience of evaluator • semantic/semiotic content priority • confidence, politics, resources, audiences, purposes, boundaries	**3. Evaluator sets Questions and Standards** • phases: analysis, design, development, implementation
4. Client feedback Message to Evaluator • client-helpful • field-helpful • audience-helpful • expectations • spontaneous vs. systematic	**5. Evaluator Represents Feedback** • effort, rapport • match mismatch • objectives, management, or perception-based • changes between task & feedback: overt/covert • formative vs. summative • internal vs. external	**6. Negotiate Paradigm and Schema Setting** • negotiated vs. independent • response certitude, framing • self-set vs. assigned standards

INPUTS WITHIN CONTEXTS	PROCESSES	OUTPUTS
PHASE 2: DESCRIPTIONS		
7. Evaluator collects data • qualitative vs. quantitative • stable vs. changing • indwelling vs. 1-shot • intuitive vs. analytical • maximal/optimal/actual • disjunctive vs. conjunctive • additive vs. dicretionary	**8. Evaluator analyzes data** • information load • description vs. judgement • anticipated vs. unanticipated • analysis model • audience analysis	**9. Evaluator Reports Initial Descriptions** • feedback time: simultaneous vs equential prove/improve
10. Client Feedback Message to Evaluator • initial certitude • credibility of Evaluator • match-mismatch • selective perception	**11. Evaluator Represents Client's Feedback** • prove/improve • quantitative, qualitative or holistic • overt vs. covert • subjective, intersubjective, objective • balance of positive/negative feedback	**12. Evaluator Edits Descriptions and Reports Alternatives** • feedback time • framing • heuristics vs. algorithyms • implications

INPUTS WITHIN CONTEXTS PHASE 3: JUDGEMENTS	PROCESSES	OUTPUTS
INFORMATION	PERCEPTUAL REPRESENTATION	ACTION, RESPONSE, AND/OR JUDGMENT
13. Client's Feedback Message to Evaluator • expect gains or losses • truth vs utility • Client's certitiude • purposes & resources • selective perception • strategic myopia	**14. Evaluator's Editing of Alternatives** • concrete vs abstract • duration of events • display format • self efficacy	**15. Evaluator Rates Alternatives** • feedback processing time
	16. Evaluator/Client Judgment • inductive, deductive, abductive • heuristic vs normative; • confidence of Evaluator, • expectations: internal vs external • overt vs covert; proactive vs reactive • uncertainty of decision: cognitive dissonance	**17. Delivery Matrix & Recommendations** • time and format of delivery

Inputs Within Contexts	Processes	Outputs
Phase 4: Decisions & Choices		
Information	Perceptual Representation	Action, Response, and/or Judgment
	18. Decision Mechanism • satisfice • self-initiated vs imposed • role of Evaluator and Client in decisions • risk taking vs risk seeking: error penalties • novice vs exper	
	19. Choice Mechanism • perceived self-efficacy • environmental demands (closed, open or optimizing system) • elitist vs subordiante • attractiveness of alternatives/ incentives • past expenditures of effort • performance valence: short & long term • press/compensate/integrate/ inaction	**20. Outcomes & Implementation**

Table 1. Criteria for Evaluating Instructional Hypermedia

1. Intertextuality and Intermediality

- what is the nature of the learner (prior knowledge, reflexive skills, expectations, motivation)?
- what is the instructional model used (e.g., eclectic or theory based)?
- what supports (e.g., focusing, hints and shaping) are provided for the user/learner ?
- what levels of information are included and what is the size and range of the knowledge base?
- how is information related (e.g., synchrony versus historical, diffuse versus focused, traditional work structures versus dynamic culture and discourse)?
- how is linear and nonlinear information linked?
- how is content granularity developed (e.g., how is relevant from irrelevant information filtered, chunking, degree of modularization)?
- how can hypermedia be structured to replicate content structures or knowledge structures?
- how is remediation versus enrichment information access provided?
- as instruction becomes richer, how does abstraction emerge (and is it backed by sufficient examples, practice, and alternative representations in different modalities)?

2. Decentering and Recentering

- how does the instructional model impose organization?
- how does the software impose organization: hierarchically and referentially?
- how are learner and teacher contexts defined and managed over time?
- what kind of representations are included in the courseware: hierarchical, relational and/or dialectical?
- what are the possibilities revealed by alternative sign systems?
- what objects are used in representations? how realistically are situations protrayed?
- what is the understanding of the conceptual structure of the information by learner and designer?
- what is the impact of different sequences of decentering and recentering?
- how do users assess different representations?
- how is decentering skill related to explicit organization and indivdual knowledge structures?

3. Navigating Networks: Achieving Cognitive Search Space

- how is exploration conceived by the developers? what charting procedures exist?
- how do learners use their increasing power over the sequencing of material to gain meaning?
- to what extent are hypermedia users (and developers) bound by acculturation to book technology?
- when and how are links denoted meaningfully (at the start of a node or within it)? Of a related nature, should specific parts of the screen be reserved for links? When should links be imposed and when should they be learner defined?
- how many nodes can be displayed at one time without being confusing?
- how do learners avoid getting lost in "hyperspace"? how much support exists for "dynamic" linking? (e.g., mapping and audit trails)
- how can designers accommodate to both self-learners and those needing more external structure?
- when is it effective to insert critical questions, navigational guidance or hints to users?
- how can higher order thinking like hypothesis formation be prompted?
- how can various imagery and sounds/intonations be used to access emotions?
- when do sound and visual realities need to be separated for user load given different symbolic systems being used?

4. Boundaries between Experts and Novices

- what methods for information retrieval are available?
- what methods are used for structuring hypermedia: deductive, inductive &/or abductive?
- what methods of browsing are available (e.g., single word/phrase search, Boolean logic, alphabetical index of node names, graphic maps of node relations)?
- how well does planning match execution of novice and expert access strategies?
- how representative are learning levels of development team? Additionally, to what degree are they captured in a mindset (e.g., prescriptive) ?
- how effective is transition from novice to expert stages (i.e., when to use advisors such as online and offline instructional aides, use of adjunct and guiding questions, heuristics, modelling--and combinations thereof)?
- how smoothly can the learner move between two representations?
- to what degree are metacognitive or self-learning skills overtly taught?
- to what extent is heuristic guidance content specific in hypermedia contexts? when should information be suppressed?
- what are the motivational effects of learner control as they transition through the hypermedia environment?
- when is it beneficial for the learner to discover various paths on their own rather than via the minimal path?

5. Boundaries of Individual Work

- to what extent do metaphors emerge that help us conceptualize this complexity?
- to what extent are designers of hypermedia tacitly influenced by a print-based mentality?
- how does hypermedia influence an author's cognitive load (e.g., capacity to make decisions about links, content and transitions)?
- when does the author and the user perceive the significance of the link?
- how should links be denoted that have the same referent given hypermedia's capacity to indicate the relational strength of each node?
- what grammar can be established that portrays information non-linearly?

Title:

A Comprehensive Review of Learner-Control: The Role of Learner Characteristics

Author:

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Abstract

The current paper reviews findings from over seventy published studies investigating various facets of learner-control in computer-based instruction. General conclusions about the relative effectiveness of "learner-control" versus "program-control" are equivocal. Across these studies, however, are strong suggestions that a number of individual learner differences can greatly contribute to both the choices students make and to the effectiveness of those choices. Some researchers (e.g. Carrier & Williams, 1988; Ross & Rakow, 1981; Snow, 1979; Tobias, 1987a) examine those differences operating on a global level, interacting with such broad instructional variables as "learner-control" versus "program-control," following an aptitude-treatment interaction paradigm (ATI; see Cronbach & Snow, 1977). Other investigators, however, look for interactions occurring on a moment-by-moment basis under micro-instructional conditions, that is, the task-specific situations encountered during the course of the lesson delivery (e.g. Fisher, Blackwell, Garcia, & Greene, 1975; Johansen & Tennyson, 1983; Seidel, Wagner, Rosenblatt, Hillelsohn, & Stelzer, 1975). Other paradigms are also discussed.

This review extends the previous surveys of Carrier, (1984), Hannafin, (1984), Milheim and Martin (1991), and Steinberg, (1977, 1989) paying particular attention to the role of learner individual differences in the effectiveness of learner-controlled CBI. Specifically, the impact on learner-control effectiveness of both rational-cognitive processes and emotional-motivational states of the learner are highlighted. Useful instructional prescriptions are proposed which take into account these variables. Recommendations for future research are offered.

Learner-control of instruction: Overview

A supposed advantage of computer-based instruction (CBI) over more traditional forms of instruction is its capability to deliver to students "individualized" lessons. That is, the computer can assemble and present to different students tailored lessons with wide variations in sequence of information, amounts of examples and practice questions, or kinds of feedback and review, to name just a few possibilities. Alternatively, the computer may abrogate such decisions and allow the learner to select the instruction they are to receive. Here, the learner operates to control the "flow" or "path" of instructional materials.

To many educators and instructional designers, the phrase "learner-controlled instruction" suggests a class of instructional events or tactics intended to increase learner involvement, mental investment (or "mindfulness," as Salomon, 1983, would put it), and achievement. The approach is to emphasize the learner's freedom to choose their learning activities to suit their own individual preferences and needs.

There are many common instances of computer-based activities falling under the general rubric of "learner-control." For example,

- …standard computer-based instruction for direct instruction (e.g. drill & practice or tutorial). This type of software follows an overall instructional design strategy, but permits the students to make their own decisions about, for example, what topics to see and when, how many exercises to take, or when to quit the lesson.
- …computer-based simulations. These programs operate almost entirely under the learner's control (Reigeluth & Schwartz, 1989) in that the continual and often complex manipulations of the simulation's parameters are nearly totaly left to the discretion of the learner.
- …tools for indirect learning such as word processing, programming, telecommunications, and databases. Billings (1982) argues that these tools are of a different class from typical computer-assisted instructional lessons. She argues that in these applications learner-control is inherent in the software and offers the potential for more complex learning by the students than more traditional instruction. The object here is not that the student should learn the tools for their own sake, but rather that these softwares be utilized in the pursuit of other learning outcomes (e.g. writing skills, mathematical reasoning, critical thinking).
- …instruction developed around "hypermedia" technologies (e.g. Bowers & Tsai, 1990). Such innovations offer to learners previously unconceived freedom of movement and choice of media displays. So-called "electronic encyclopedias," especially those designed for K-12 school use, are examples of this type of technology. The structures of these databases have important implications for information accessibility and the ease of navigation around the database, i.e. what learner-control features are offered (Duchastel, 1986a).
- …on-line computer documentation which allows the user the options of either following a detailed walk-through of major procedures and functions, or jumping around according to the needs of the moment. These "help" features most commonly serve as simply performance job-aids; but they are frequently used as aids for learning, as well.

And as the newer instructional technologies, both hardware and software, proliferate into instructional settings, the possibilities and variations for including learner-controlled activities in instructional designs will likewise multiply.

The first arena of CBI mentioned above, that is, traditional computer-based lessons for direct instruction, presents the largest research base of studies investigating issues of learner-control, and will form the concentration of this review. Suggestions for future research in other arenas are discussed at the conlusion of the paper.

Types of learner-controlled activities

Intentionally or by accident, most instructional designs end up consisting of a mixture of learner-controlled and instructor-prescribed learning experiences. Romiszowski (1986) describes four "levels" for which the designer will need to make decisions about the source of instructional control, the first three are more or less at a "macro" level, that is, apply to large instructional units such as curricula, units, and lessons. (For a discussion of many of the forms which instruction can take at the macro levels when under learner-control, see Gagné, Briggs, and Wager, 1988; Huff, 1984/1985; Rowntree, 1986; and Young, 1982.)

At the lowest level, Romiszowski (1986) recommends that designers consider whether and how to provide learner-control over "micro" instructional experiences, that is, those learning activities which occur within lessons, whose durations span minutes rather than hours or days. Indeed, because CBI seems particularly well-suited to managing such specific micro-instructional events (Gagné, Wager, & Rojas, 1981; Gagné, 1985), the bulk of research on learner-control in CBI falls at the "micro" level.

Several researchers have proposed lists of computer-based micro-instructional activities which they say could or should fall under the heading of "learner-controlled." Steinberg (1984), for example, lists a range of these events which might be offered within a learner-controlled lesson: which topics to study and in what order; number of exercises to practice and their level of difficulty; presentation of review or supplementary materials; the option not to answer questions. Other activities, too, could be made optional: amount or kind of feedback to see following practice questions; whether to exit the instruction; mode of presentation (e.g. verbal or graphic); and even the option whether to allow further learner-control at all.

Laurillard (1987) presents another assortment of computer-based learning strategies which learners might be given control. One category of these strategies, *control of content sequence*, includes provisions for the student to skip forward or backward a chosen amount or to retrace a route through the material, and options to control when to view such features as content indexes or content maps. A rather remarkable early example of learner-control of content sequence in computer-based instruction comes from Grubb (1968). He describes a system whereby the student, with the aid of a light-pen and a content map on the screen, is able to point and jump to any subtopic in the lesson. This approach presages the current "hypertext" environments in which students proceed through instruction in a non-linear "browsing" fashion.

Another category presented by Laurillard (1987) is called *control of learning activities*, and includes options for the student to see examples, do exercises, receive information, consult a glossary, ask for more explanation, and take a quiz. Most of her list of learner-controlled activities is included in Steinberg's (1984) list, but Laurillard's seems more complete and grounded in theory.

Milheim and Martin (1991) present three types of variables for which students might be granted control: *control of pacing*, that is, the speed of presentation of instructional materials; and *control of content*, permitting students to skip over certain instructional units. They suggest that these categories, in addition to *control of sequence* (similar to Laurillard's *control of content sequence*), represent the most germane sets of instructional variables affecting the success or failure of learner-controlled CBI.

These categorization schemes overlap to a large degree and differ primarily in perspective or orientation. And all provide useful information for designers and researchers studying the use of learner-control in CBI.

Historical background

The idea of learner-control of instruction has a fairly long history which pre-dates the educational use of computers. Some these early efforts at developing learner-controlled instruction grew out of a reaction to the stiffness and inflexibility of programmed learning approaches. For example, Mager and Clark (1963) suggest that while certain remedial branching techniques used in programmed instruction work well for poorly performing students, more knowledgeable students are better able to determine their own instructional paths. Campbell (1964), too, suggests that learner-control over instruction is at least as effective as programmed instruction, and perhaps more so for complex learning outcomes such as problem-solving and transfer. In a related study, Campbell and Chapman (1967) found that over a long period of time, learners who controlled their own instructional paths developed a greater interest in the subject matter, took less time, and performed as well as subjects in the programmed group. They also found that although scores on tests early in the eight month course favored the programmed group, over time scores in the learner-controlled group increased to parity with the program-control students.

Other justifications for developing, learner-controlled or "self-guided" instruction grew out of early efforts to *individualize* instruction. Individualization in these approaches usually referred to instruction which allowed learners to proceed through instruction at their own convenience and at their own pace.

Reiser's (1987) chapter on the history of educational technology traces many important contributions in the evolution of learner-controlled instruction. For example, Postlethwait, Novak, and Murray (1972) created the *Audio-Tutorial Approach*, in which learners proceed through a variety of mediated materials at their own pace, following guidance from a conversational audiotape. Another popular approach was called the *Personalized System of Instruction* (*PSI* or *Keller Plan*; F.S. Keller, 1974). Keller's approach contained five distinguishing features: a mastery requirement; self-pacing; student proctors; a reliance on written instruction; and a de-emphasis on lectures.

Most current literature seems to favor two other phrases as being fairly synonymous with "learner-controlled instruction": "self-guided" and "self-managed" instruction. All of these terms broadly imply instruction where learners are in charge of navigating themselves through instructional activities.

Current rationale for learner-control in CBI

There seems to be several philosophical, practical, and theoretical reasons for allowing learners some control during CBI lessons. For example, the use of traditional, rather rigidly controlled computer-assisted instruction may actually run counter to the educational philosophies promoted by many teachers in the arts and humanities which encourage student exploration and expression. D.W. Hansen (1982/1983) argues that allowing students more user-control will increase the chance these teachers would want to include computer-based activities in their classes.

On a more practical level, Steinberg (1984) says that, if learning is found to be equivalent in both learner- and computer- controlled settings, design costs should shrink, time spent learning should be reduced, and attitudes and motivation should become more positive if a learner-controlled framework for instruction is adopted.

In his instructional design theory, Merrill (1983) prescribes learner-control of content (encompassing curriculum, lesson, and module selection) and of strategy (which includes various forms of presentation). Faust (1974), Fine (1972), and Bunderson (1974) present an assortment of learner-controlled activities derived from Merrill's early theory (Merrill, 1973; Reigeluth, 1979). The *TICCIT* (*T*ime-Shared *I*nteractive, *C*omputer *C*ontrolled *I*nformation *T*elevision) system provides the learner with many options some of which are dependent on the current course (such as reviews, menus, quizzes, faster/ slower, type of feedback, level of question difficulty, and topic surveys) and others are constant across any course delivered by the system (such as backward or forward movement, access to a calculator, access to a glossary, and opportunity to leave on online comment; there is even a feature which gives the student the option to "CUSS" at the computer when things go wrong!).

Reigeluth and Stein (1983) in their instructional design theory also hypothesize that "…instruction generally increases in effectiveness, efficiency, and appeal to the extent that it permits informed learner-control by motivated learners" (p. 362). Federico (1980) suggests that learner-control might be a useful alternative to the classic aptitude-by-treatment interaction approach, in that, "learners can become system independent by enabling them to manipulate and accommodate treatments to their own momentary cognitive requirements" (p. 17).

Additional rationale from a different perspective comes from a survey of adult learning preferences. Penland (1979) found that the top four reasons why adults prefer learning on their own were expressed as desires to "set my own learning pace," "use my own style of learning," "keep the learning strategy flexible," and "put my own structure on the learning project." Discussing the differences between adults and children, Hannafin (1984) argues that under CBI conditions, older students should realize the benefits from learner-control more than younger students because they have acquired more (and presumably better) learning strategies.

Some of the research from the psychology of basic learning processes also implies possible advantages of learner-control. For example, one might expect a learner-controlled instructional treatment to induce more elaborate mental processing from the student as a result of their pondering the choices with which they are faced. Salomon (1983, 1985) refers to the degree of such mental activity as "invested mental effort." The more such effort expended, he implies, the more mental elaborations the student performs, resulting in deeper, more meaningful learning. In contrast, one might not expect as much cognitive elaboration from students proceeding through a more "passive" instructional treatment. In plain language, learners given control over their instruction might be more likely to think about what they are doing because they have to make choices along the way.

Hartley (1985), too, in arguing for the need for more attention to basic psychological processes when studying the impact of computers on learning, supports the use of learner-control of instruction as a means for students to develop their own cognitive structures. That is, consistent with a constructivist view of knowledge acquisition, he proposes that the learning of complex knowledge structures is facilitated when the learner himself/herself can participate in the construction of those mental structures. This constructivist approach is also promoted by Salomon and Gardner (1986) who suggest that "...individuals mold their own experiences by the traits and goals they bring to the encounter, the way they apprehend the technology and the situation, and the particular volitional choices they make. In so doing, learners, particularly when given interactive opportunities with computers, are likely to affect the way these opportunities are going to affect them" (p. 16).

The effectiveness of learner-control in CBI

Unfortunately, the research on learner-control in instructional contexts does not support its unconditional use. Many authors of texts on CBI design caution against cavalierly offering a variety of options to learners (e.g. Alessi & Trollip, 1985; Jonassen & Hannum, 1987; Steinberg, 1984) because such a strategy does not seem to improve overall learning. O'Shea and Self (1983, chap. 3) summarize much of the unpublished research on the effectiveness of the early *TICCIT* system and conclude that it is difficult to support its widespread use. Merrill (1983), too, concludes that college level students generally do not make good use of learner-control options, a position also taken by Carrier (1984). Snow (1980), commenting on the use of learner-control in adaptive instruction, argues that far from eliminating the effects of individual differences on learning, providing learner-control may actually exacerbate these differences.

Research on learner-control in CBI has typically compared learner-controlled and program-controlled treatments in a fashion reminiscent of and analogous to media comparison studies conducted in the 1960's and 70's. The following is a summary of research findings comparing learner-controlled computer-based instruction with either partial learner-controlled versions or complete computer-controlled versions for the three most common types of dependent variables measured in such studies, namely, *learning*, *time-on-task*, and *attitudes and affect*.

Generally speaking, these studies compare treatments which present a mixture of the specific instructional events actually subject to learner-control. Additionally, contrary to the statements of Hannafin (1984), both adults and children seem to have been well represented in these studies. Many of these studies were also reviewed by Steinberg (1977, 1989), but are discussed in this review from a somewhat different point of view.

Learning. On the whole, results have been mixed, but treatments under the learner's control have been shown most often to be as effective or less effective than treatments under more computer control. Also contrary to a suggestion by Hannafin (1984), findings from the literature reviewed here indicate that children do not seem to do any worse (or better) with instruction placed under their control than do adults.

A few studies have supported the use of learner-control of at least some instructional events (Avner, Moore, & Smith, 1980; Campanizzi, 1978; Ellermann & Free, 1990; Kinzie, Sullivan, & Berdel, 1988; Mayer, 1976; Newkirk, 1973). Most of these support Hannafin's (1984) suggestion that learner-control promotes a deeper or more long-lasting effect on memory. Newkirk (1973), for example, found a long-term learning benefit for learner-control, but not for program-control. Mayer (1976) found that more complex outcomes were learned better when learners were able to control the order of presentation while simple outcomes were learned better under experimenter-controlled conditions. In one of the few long-term studies of the effects of learner-control in CBI Avner et al. (1980) found that students using highly "interactive" learner-control showed a greater degree of high-level skills than did the students within a more "passive" type of CBI. There were no differences between these groups on low level skills, however. In a pair-associate task investigated by Ellermann and Free (1990), students who could select the order of presentation seemed to have a stronger memory-trace, implying more engagement of cognitive structures.

In contrast, studies by R.C. Atkinson (1972), Belland, Taylor, Canelos, Dwyer, and Baker (1985), Johansen and Tennyson (1983), Lee and Wong (1989), MacGregor (1988a), Morrison, Ross, and Baldwin (1992), Olivier (1971), Pollock and Sullivan (1990), Reinking and Schreiner (1985), Rivers (1972), Tennyson, Tennyson, & Rothen (1980), Tennyson and Buttrey (1980), Tennyson, Park, and Christensen (1985), Tennyson, Welsh, Christensen, and Hajovy (1985) all found various types or degrees of program-control superior to learner-control of the same instructional elements for posttest achievement. Many of these authors speak of learners not having or not knowing how to utilize appropriate strategies when they are left to themselves to manage their learning environment.

Interestingly, most studies in which the computer controlled the rate of pacing, that is, the length of time which screenfuls of information were presented to the student (Belland et al., 1985; Dalton, 1990; Tennyson, Park, & Christensen, 1985; Tennyson, Welsh, Christensen, & Hajovy, 1985), found learning under those conditions better than self-paced conditions (in which the learner controls the speed at which material is presented), the usual fixture in most CBI programs. One study by Milheim (1990), however, found learning better under learner-controlled pacing conditions.

Additionally, in a meta-analysis of 10 years of interactive video instruction, McNeil and Nelson (1991) conclude that, as a general statement program-controlled conditions are superior to learner-controlled. They suggest however, that partial (i.e., "guided") learner-control over review and practice activities might be the most optimal for learning, although they caution that too few studies included such conditions to make the conclusion unequivocal.

However, most studies found no differences between learner-controlled and program-controlled treatments (Arnone & Grabowski, 1992; Balson, Manning, Ebner, & Brooks, 1984/1985; Beard, Lorton, Searle, & Atkinson, 1973; Carrier, Davidson, Higson, & Williams, 1984; Carrier, Davidson, & Williams, 1985; Carrier, Davidson, Williams, & Kalweit, 1986; Fredericks, 1976; Goetzfried & Hannafin, 1985; Gray, 1987; Hannafin & Colamaio, 1987; Holmes, Robson, & Steward, 1985; Hurlock, Lahey, & McCann, 1974; Judd, Bunderson, & Bessent, 1970; Judd, O'Neil, & Spelt, 1974a; Kinzie & Sullivan, 1989; Klein & Keller, 1990; Lahey, 1978; Lahey & Coady, 1978; Lahey, Crawford, & Hurlock, 1976; Lahey, Hurlock, & McCann, 1973; López & Harper, 1989; McCann, Lahey, & Hurlock, 1973; Pridemore & Klein, 1991; Ross, Morrison, & O'Dell, 1988, 1989; Schloss, Wisniewski, & Cartwright, 1988; Strickland & Wilcox, 1978; Wilcox, Richards, Merrill, Christensen, & Rosenvall, 1978; Williams, 1992). The various conclusions drawn from this "no-difference" finding are interesting and tend to reflect a good deal of rationalization. Some of the researchers use this finding to support the use of learner-control, saying that programming the computer to handle the myriad complex types of branching which could potentially occur in a lesson is far too difficult. So therefore, since their research indicates it would at least do no harm, it is better to let the student handle their own lesson branching. Other researchers use the "no-difference" result to justify program-control of instruction, saying that other benefits, such as time savings (discussed next) are realized by not letting learners control their own instructional paths.

Time-on-task. Several studies also included as a dependent variable the length of time students took to complete a lesson. Two studies found students in learner-controlled CBI groups taking more time to finish the lesson than program-controlled groups. In a study by MacGregor (1988a), elementary students worked in pairs, and those in the learner-controlled group were given the opportunity to participate in an online instructional game; students in the program-controlled group were not. The author attributed the time-on-task differences to the fact that the game aroused quite a bit of interest, thus generating a lot of talking and other social activity within the pairs, naturally consuming more time in the process. Dalton (1990) also found that students in a condition in which the computer controlled the pacing of materials spent more time than those in learner-controlled pacing. He, too, suggests that the amount of socializing observed among the paired members of the learner-controlled condition accounted for the longer time spent. Another study (Avner et al., 1980) found that while students in learner-control conditions spent more time during online tasks, they spent less time during related offline tasks, in this case laboratory activities.

A few studies found no differences in time spent (Hurlock et al., 1974; Kinzie & Sullivan, 1989; Lahey et al., 1973). The bulk of studies, however, found that learner-controlled groups spent considerably less time than program-controlled groups (Fredericks, 1976; Johansen & Tennyson, 1983; Lahey et al., 1976; Rivers, 1972; Ross et al., 1988; Tennyson et al., 1980; Tennyson, 1980; Tennyson & Buttrey, 1980).

Researchers investigating "efficiency" of time spent during a lesson found mixed results. Dalton (1990) found no differences on achievement-per-time-spent between self-paced and lesson-paced interactive video formats. Another study (Goetzfried & Hannafin, 1985) did find differences between groups on an efficiency variable they define as the number of concepts a student sees per minute. In their study, learner-control was the least efficient, that is, promoted a slower progression through the lesson.

In some of these studies (Goetzfried & Hannafin, 1985; Johansen & Tennyson, 1983; Tennyson et al., 1980; Tennyson, 1980; Tennyson & Buttrey, 1980), shorter time was also linked to poorer performance. One possible explanation for these findings lies in the confounding of instructional control, time-on-task, and amount of instructional material seen. That is, learners navigating their way through a lesson might spend less time because they opted to skip over large amounts of instructional material. If this omitted material were crucial for overall lesson performance, these students might naturally be expected to perform more poorly than would students progressing through a program-controlled, but more "complete" lesson package. Lepper (1985) suggests that students under learner-control might see differing amounts or kinds of instructional material than students under program-controlled treatments. (In fact, for some situations it is entirely likely that each student under learner-control selected their way through a completely different instructional treatment!) Therefore, in these studies we do not know whether the culprit for the supposed failure of learner-control is the fact that students were granted control, per se, or simply saw suboptimal amounts of instruction as a result of "poor" choices. Indeed, three of these studies do report that students in learner-control spent less time because they saw fewer instructional screens, (e.g. fewer examples). This issue surfaces again later in this paper.

Commenting on the problem of learners choosing low amounts of instruction, Higginbotham-Wheat (1988) and Ross and Morrison (1989) draw the conclusion that learner-controlled instruction should only allow students to select context, sequence, and presentation style variables, and should not allow students to choose instructional events which could alter the amount of content support. It seems safe to say that the confounding of learner-control, time-on-task, and amount of instructional material is a matter which can prevent clear conclusions about the relative merits of offering control to learners.

As with the findings of no difference in learning between learner- and program-controlled groups mentioned earlier, the authors of the studies who found shorter time for learner-control also are quite creative in the implications they draw from that finding. Some authors claim that if learning is equivalent, but time spent is shorter, learner-control is desired because of the time "savings" or "economies." Others say that the shorter times from the learner-control groups mean less time-on-task, an inherently undesirable outcome, and thus should be avoided.

Attitudes and Affect. Most of the studies which measured the students' attitudes toward computer-assisted instruction or toward learner-control over instruction found either no differences or a favorable attitude from students who experienced a learner-controlled treatment compared with program-controlled groups. The author of the one study which did find more negative attitudes in the learner-controlled group (Gray, 1987) explained the findings as due to resentment and frustration at the complexity of the instructional decisions the students under the learner-controlled condition were required to make.

A few studies (Arnone & Grabowski, 1992; Beard et al., 1973; Judd et al., 1970; Kinzie et al., 1988; Lahey, 1978; Pridemore & Klein, 1991) found no differences in student attitude toward CAI between learner-control and program-control groups. Additionally, one review (Judd, 1972) also concluded that generally, learner-control does not contribute to improved attitudes. However, it is quite possible that the early computer studies included in Judd's paper do not exactly represent the highly interactive approaches used for instruction on modern microcomputers.

Six studies did find positive attitude effects for students in learner-control groups (Hintze, Mohr, & Wenzel, 1988; Hurlock et al., 1974; Judd et al. 1974a; Milheim, 1989; Morrison et al., 1992; Newkirk, 1973). For example, the study by Milheim (1989) exploring computer-driven (interactive) videodisk instruction found better attitudes toward the instructional activity for students under learner-control pacing compared with students who experienced program-control of lesson pacing. In most of the studies examining attitudes, students were only exposed to one type of program (i.e., they only saw a learner-controlled version or a program-controlled version). One of the most interesting of all the studies examining attitudes is presented by Hintze et al. (1988) who compared attitudes in dental students in Denmark, each of whom actually had a chance to experience several versions: completely learner-controlled; partially learner-controlled; and computer-controlled instructional situations. They found the overwhelming majority of students preferred at least some learner-control. Interestingly, males by far preferred complete learner-control, while female preferences were split between partial and total learner-control preferences. Dalton (1990) also found some interesting interactions between gender and learner- or program-controlled treatments on attitudes. Specifically, he found that females under lesson-controlled pacing ended up with better attitudes toward instruction and toward the content of the lesson than females under learner-controlled pacing. Males, however, under program-controlled pacing had significantly worse attitudes toward content than males under learner-paced lessons.

Some researchers investigated the effects of learner-controlled instruction on one particular type of attitude measure called *continuing motivation* (Maehr, 1976; Seymour, Sullivan, Story, & Mosley, 1987) which indicates how likely a student's ongoing willingness to return to a learning activity at a later time without external pressure, essentially a variable measuring the student's desire to learn voluntarily. Kinzie and Sullivan (1989) found positive effects on the students' desire to pursue science activities following computer assisted instruction, generally, and following learner-controlled CAI, specifically. However, this effect was not replicated by López and Harper (1989) who found no advantage for learner-control over program-control on continuing motivation.

Lastly, a few early studies investigated the effects of learner-controlled computer-based instruction on student state (i.e., temporary) anxiety, with mixed results. Judd (1972) recaps one study which shows a reduction in anxiety as a result of learner-controlled CBI. J.B. Hansen (1974) also found a lowering of initial state anxiety as a result of learner-control over computer-delivered feedback. However, neither Judd, O'Neil, and Spelt (1974b) nor Judd, Daubek, and O'Neil (1975) were able to lower state anxiety as a result of their particular types of learner-control (control over access to mnemonic devices in the first case, and control over access to pictures in the second case).

Summary of the effectiveness of learner-control of CBI. After reviewing all of these findings for the various types of dependent variables, we are presented with an apparent dilemma: learner-control *should* be better than program-control; however, students left on their own do not uniformly make good use such strategies. Duchastel (1986b) sums up the frustrating ambiguity of learner-control research: "Nevertheless, the research leads one to be cautious about the general learner-control hypothesis, namely that the student is the best judge of the instructional strategy to be adopted. Some results in instructional research indicate that not all students are capable of making appropriate educational decisions. Other results, however, indicate the tremendous benefits of learner-control in particular situations. The sophistication of the learner and the type of objectives pursued, as well as the particular context of the system, will probably impact on the nature and effectiveness of learner-control in given situations." (p. 391)

The role of learner characteristics

Individual learner characteristics play a huge role, of course, in how fast and how well overall learning will occur. Since its inception, CBI has continually been held up as a promising vehicle able to somehow tailor instruction to meet the individual needs of each learner (Suppes, 1966; U.S. Congress, Office of Technology Assessment, 1988). Just how these instructional adaptations are best generated, however, is a matter of debate.

Some proposals for adaptive CBI are program-controlled and attempt to present to each student appropriately matched instructional events according to some relevant individual difference variable. Examples of such approaches include: regression models which stable trait variables (McCombs & McDaniel, 1981) or on-task state variables (Rivers, 1972) to optimize instructional presentations; or schemes to branch instruction according to some optimizing mathematical model (R.C. Atkinson, 1972; Holland, 1977; Smallwood, 1962; Tennyson, Christensen, & Park, 1984). Few of these approaches have made it into commercially produced CBI, however.

On the other hand, for reasons of feasibility, attractiveness, and understandability, most of the CBI found in school software libraries has at least some learner-controlled features which their manufacturers tout as helping to accommodate the learning needs of each individual student. The idea, as Merrill (1973, 1975) and Federico (1980) have propounded, is that students will make their own decisions throughout a lesson so as to best match their own learning styles, personality, or other relevant traits.

As we have seen, however, learner-control does not seem to be a superior overall strategy. However, a closer examination does seem to indicate differential student effectiveness of instructional choice and options use, although perhaps not in the way the software producers had intended. That is, some students are able to use learner-control to their advantage; others, however, use it actually to their detriment.

Paradigms. There are several methods available to researchers wishing to study the interaction between learner characteristics and learner-controlled CBI. One common approach examines such an interaction within an "aptitude-by-treatment interaction" (ATI; Cronbach & Snow, 1977) perspective. That is, students stable cognitive and personality "trait" variables are viewed as possibly interacting with predetermined instructional features to produce differentially effective learning, particularly within a learner-controlled context (Snow, 1980). One example is found in Judd et al.(1974a) who found that the personality variable of "achievement via independence" predicts certain behaviors under learner-control. Snow (1979) also takes an ATI approach and presents some data using various statistical profiling techniques which appear to be fairly successful at sorting college students enrolled in a BASIC programming course into good and poor options selectors according to their scores on a variety of aptitude measures.

But the usual aim of ATI studies is to find instructional treatments which would somehow benefit students possessing different learner characteristics or profiles. However, in spite of Federico's (1980) suggestion that learner-control might allow students to effectively select instances based on their own cognitive requirements, there is ample evidence that learner-control serves to *magnify* student differences rather than eliminate them. Wilcox (1979) for instance, presents a review of non-computer-based ATI studies and concludes that learner-control tends to exacerbate problems arising from individual differences instead of minimizing them. Snow (1980), too, argues that a learning environment which allows learners to control instruction might possibly produce *stronger* relationships between individual differences and learning to the degree that these individual differences are free to operate than would "fixed" instruction. In a variation on ATI approaches which Tobias (1976) calls an "achievement-by-treatment interaction," differential results have also been found for effectiveness of options selection for students with differing amounts of prior knowledge (Ross & Rakow, 1981; Tobias, 1987a).

Merrill (1975) discusses several assumptions regarding "aptitudes" and "treatments" in Cronbach and Snow's (1977) ATI model. He points out that quite often the most germane learner characteristics are unstable and vary from moment to moment during instruction. Likewise, treatment effects may similarly not always hold under the variety of conditions present in typical educational settings. Lastly, he argues that instead of instruction being adapted to the individual, we should allow the students to adapt the instruction for him/herself. This forms one of the bases for the inclusion and importance of learner-control in his theory of instruction.

That is, while ATI approaches seek to understand the differential effectiveness of learner-control with individual differences measured *prior* to instructional intervention ("trait" variables), other approaches choose to explore learner variables measured *during* the instructional task, so-called "within-task" variables (Federico, 1980) or situational "state" variables. These presumably reflect momentary variations in certain learner characteristics which also could interact with the specific instructional situation. Tennyson and Park (1984) discuss the need to investigate the phenomena of moment-by-moment interactions of instruction and individual differences, in particular within learner-controlled environments.

Studies by Seidel, Wagner, Rosenblatt, Hillelsohn, and Stelzer (1975) examining students' ongoing expectancies of success, by Fisher, Blackwell, Garcia, & Greene (1975) on momentary changes in attributions for success and failure, and by Goetzfried and Hannafin (1985), Johansen and Tennyson (1983), Tennyson (1981) and Tennyson and Buttrey (1980) investigating on-task mastery self-assessment by students, illustrate the utility of variables which occur during the course of learner-controlled CBI.

However, still another possibility not discussed by either Cronbach and Snow (1977) or Merrill (1975) is not necessarily to adapt instruction to fit the student, but rather to attempt to change the *student* to optimally use the instruction. That is, if we can identify modifiable characteristics of the students which typically produce dysfunctional interactions with instructional treatments, we might attempt to alter those characteristics so the student and instruction are better matched.

So, both person and instruction variables can be considered either stable or unstable, perhaps reciprocally changing throughout the course of instruction. This paradigm also allows for the occurrence of aptitude-by-treatment "corrections" (Gehlbach, 1979), that is, selecting treatments to *eliminate* the effects of individual differences rather than to accommodate them.

This expanded "adaptive instruction" paradigm presents a revised set of larger questions to the researcher: when might instruction respond to variations (both stable and unstable) in individual learners; and how might learners react and respond to changes (macro and micro) in the instruction? Within this framework, there seems to be sufficient theoretical, empirical, and practical justification for investigating the mutual relationship between learner differences and instruction under some degree of learner-control.

Instructional choice

Learner-controlled instruction is, by definition, instruction where students are required to make decisions at various points. In order to guide the design and use of learner-control, it is necessary to understand the composition of such decisions; i.e. can we specify the precursors and effects of the decisions students will make?

Choice is at root a psychological phenomenon determined by both general and situational psychological variables. For example, a student might have a proclivity to select certain types or large numbers of optional instructional activities, generally irrespective of the specific lesson in which they may be engaged. However, the particular situation may moderate the general tendency. For example, say, as a general rule, a particular student tends to choose to experience large amounts of instruction when offered such an option. However, under certain conditions, that student may perceive specific material encountered as being, say, too easy, and may override their tendency to experience "complete" instruction. They might instead elect to skip over such material because it's "a waste of time." Both of these classes of behaviors, the general "trait" variables and the situation-specific "state" variables, vary in degree from learner to learner.

We seek at this point to identify the different kinds of person variables which, it is conjectured, in combination with the actual choices made (i.e. the instructional materials encountered) help to account for the unevenness of learning found under learner-controlled instruction.

As was pointed out earlier, Reigeluth and Stein (1983) advocate the use of "*informed* learner-control by *motivated* learners" [emphases added]. This statement suggests two qualitatively different sets of individual difference variables which could influence the effectiveness of learner-controlled instruction.

We should first be interested in a student's capacity to make rational choices (i.e. an "informed" student). "Rational" means how adequately they can appraise both the demands of the task and their own learning needs in relation to that task in order to select appropriate instructional support. Tennyson and Park (1984) call this the student's "perception of learning need," and also point out the need for its further study in order to be of use in effective learner-controlled instruction. These perceptions of learner need, too, will vary across learners.

Secondly, because both motivation and learner-controlled instruction are, at least in part, defined by choice activities, individual differences in motivational variables might also contribute to our understanding of the differential effects of learner-controlled instruction on learning. We therefore need to ask if there are there certain characteristics of the student and the task which would allow us to predict how inclined (motivated) a person is to make a particular choice? We are concerned with identifying emotion-related predispositions, tendencies, and preferences of the students which operate to direct a choice toward one alternative or another.

The review presented here examines the relationships between students' rationale understanding of their learning needs, their motivations to choose on an emotional level, their on-task performances and learning when offered instruction which is to some degree under their control. First, the rationally-cognitively oriented variables are presented. Following that is a discussion of emotional-motivational variables which influence choice and learning.

Rational-cognitive aspects of choice and learning

Two kinds of cognitive traits, prior knowledge and ability, offer useful possibilities for explaining some of the negative results of providing learners with choices during instruction. The relationships of learner-control with achievement and with ability will be presented in turn, together with some hypothetical instructional prescriptions which could take advantage of these relationships.

1. Prior knowledge. A possible explanation for these findings proposes that individuals do make appropriate decisions, but within their own perceptions of the problem at hand, not according to some optimal outside decision rules. This view suggests that an increase in an individual's accuracy of perception of their learning state in relation to the learning task should result in their making more appropriate choices. Students are therefore expected to make instructional choices which are rational only to the degree they have accurate information about their current learning state. This suggests an approach based on learner prior knowledge or achievement.

What kinds of information would students need to know to make a more rational choice of material? Certainly one important element would be some sort of estimate of how much one knows and how much one needs to learn. However, there is substantial evidence that, left on their own, both children and adults very often overestimate how much they know about a given topic, and indeed, perhaps those with more knowledge are better able to judge their knowledge level than people fairly ignorant in that area (Flavell, 1979; Lichtenstein & Fischhoff, 1977; Nelson, Leonesio, Shimamura, Landwehr, & Narens, 1982).

This finding that students are generally poor at estimating their current state of knowledge extends also to computer-based contexts. Lee and Wong (1989) found students unable to predict their own learning of both general and specific types of knowledge. Additionally, Garhart and Hannafin (1986) found little correlation between self-rating of knowledge and performance on several tests. These latter authors use this finding plausibly to explain why many students under learner-controlled conditions tend to terminate instruction prematurely (e.g. the review of *TICCIT* by O'Shea & Self, 1983, mentioned earlier).

It could very well be, then, that people often really don't know what they don't know, and that those who know very little know even less about what they don't know. (Apologies for the last sentence.) If this is the case, one would predict that students with higher levels of knowledge would make wiser choices (better instructional decisions) than those with lower knowledge levels. Evidence for this phenomenon is provided by Seidel et al. (1975) and Fredericks (1976). In learner-control CBI studies, high performers were much more able than low performers to estimate their performance capabilities prior to their taking quizzes on the lesson material.

The notion that poor performers are incapable of judging how much they know has implications for the idea of instructional support, as well. That is, if students are unable to estimate their current state of knowledge, they may also be unable to assess whether they need additional instruction when given the chance to choose more. This would imply that a pretest given prior to instruction could predict the success of students given learner-controlled instruction, an extension of the achievement-treatment interaction notion of Tobias (1976, 1981), but here the instructional support is controlled by the learners. Such an interaction has indeed been found in studies by Ross and Rakow (1981) and Ross, Rakow, and Bush (1980), although neither study occurred in a computer-based environment. College students scoring higher on a pretest performed as well under learner-control as similar students under program-control. This was not the case for low prior knowledge students who performed much worse under learner-control. It is plausible that low prior knowledge students were not as able to judge the instructional support they needed as were higher prior knowledge students.

Additional evidence within a CBI context is provided by Tobias (1987a) who found that knowledgeable students (as measured by a pretest) selected more options to review material than did less knowledgeable students. He states, "...the presence of instructional support is no guarantee that less knowledgeable students will use it frequently or effectively to improve learning" (p. 160). This is echoed by Judd et al. (1970) who found a similar result in their early study, namely that students who need additional instructional support tend to avoid seeking it.

So, prior achievement has been found to be a major factor affecting the effectiveness of learner-controlled instruction. A reasonable interpretation for this is that students with some knowledge about the topic being taught seem better able to sense at any given choice point what they don't know and to choose additional instructional support accordingly. Here the key instructional variable seems to be amount of instructional support. Students with low amounts of topic knowledge have inaccurate perceptions of what they know, and consequently make poor use of needed instructional support. Two possibilities for improving the effectiveness of learner-control are suggested: informing learners directly of their progress (i.e. supplanting the self-monitoring function); and instructing students to try to gauge their current knowledge (i.e. activating the self-monitoring function).

The students' continual estimation of their level of knowledge (a metacognitive strategy, according to Flavell, 1979) affects the effectiveness of their choices. Without data from the instruction about their knowledge level, students with more prior learning seem better able to assess what they do and do not know, and therefore how much more or what kinds of instruction (i.e. optional material) they need to see. Hannafin (1984), Milheim and Martin (1991), and Steinberg (1989) suggest that learner-control which regularly informs the learner of the state of their learning might provide an aid, perhaps in the form of coaching or advisement to the students, in deciding whether they need more instruction.

Additionally, Steinberg (1989) suggests that instruction should gradually wean the student from such crutches in order to promote more internalization of the metacognitive processes. Such information supports to the learner fall under the category of "decision aids" which have been shown to be quite useful in helping people make judgments and select appropriate courses of action (Pitz & Sachs, 1984).

Related to the case where students left to assess their own current learning state is the case where this assessment is performed by the instructional program (a "decision aid") during the course of the lesson. One would also predict that providing students with updated information as to their moment-by-moment mastery level would improve the effectiveness of learner-control over providing no such information. Studies by Arnone and Grabowski (1992), Holmes et al. (1985), Schloss et al. (1988), Tennyson (1980, 1981) and Tennyson and Buttrey (1980) support this contention. Here the researchers provide students under learner-control with such information and show beneficial effects over students not given such information. Related to these studies is a study by Steinberg, Baskin, & Hofer (1986) who found that providing informative feedback to students during the course of a CBI lesson increased the chances that learner-controlled memory tools would be used. That is, students were able to use the feedback information to help them decide when and how to use the memory tools.

Results are not unequivocal, however. Ross et al. (1988) did not find an interaction between student selection of density of text displayed on the computer screen (high and low densities) and student pretest scores. Additionally, Goetzfried and Hannafin (1985) did not replicate in a CBI setting the achievement-by-treatment interaction which was demonstrated by Ross and Rakow (1981) in a non-CBI setting.

An additional wrinkle is suggested in results reported by Pridemore & Klein (1991) who compared selection of feedback by students under two learner-controlled feedback conditions differing in the elaborateness of information provided. They found generally that students in the less elaborate condition selected less feedback than those in the more elaborate condition. This suggests that students select their instructional support *only to the degree they perceive it will help them*. It's possible then, that students chooseto experience more instruction, not just based on their perceived learning need, but also on the perceived usefulness of the material to be offered.

Instruction, then, designed for learner-control should have as its goal the expansion and clarification of the student's own perception of the task and their progress toward it, particularly for those whose are deficient in the accuracy of their self-monitoring.

However, it is not known at this point whether students even need to be aware that self-monitoring is important in learner-controlled instruction as a type of learning strategy (Garner & Alexander, 1989). It might be that simple directions to the student to think about what or how much they know might be enough to dislodge them from more habitual "mindless" activity. If we could somehow activate the learners own untapped self-monitoring skills, it is speculated, then it may be unnecessary to directly inform the learners of their mastery using some decision superstructure (e.g. Bayesian probabilities, Tennyson & Rothen, 1979). This approach, however, has not been explored in learner-controlled CBI contexts.

In addition to supplanting a student's monitoring activities, or activating existing monitoring strategies, instruction might attempt to *improve* the student's conscious use of metacognitive strategies. This would involve some type of strategy training (Garner & Alexander, 1989, present a review of some of these training approaches). Tobias (1987a) supports metacognitive strategy training indicating that many students might need to be taught when and why to use various instructional supports. However, at this point, metacognitive strategy training has not been investigated in a learner-control CBI context.

2. *Learning strategies and ability*. Another explanation for the general ineffectiveness of providing instructional options begins with the suggestion that individuals have developed either good or poor means for dealing with learning problems. The metacognitive self-monitoring processes mentioned earlier in the section on *Prior Knowledge* represent a subset of a larger collection of cognitive processing strategies most often called "learning strategies." Jonassen (1985) reviews some of

the research on learning strategies, and describes four classes of strategies, all of which have clear implication for learner-controlled instruction:

- *Metacognitive strategies* are those processes which by which the student tells themself how much they know. It is often described as "self-monitoring," and reflects a sense of both knowledge and ignorance.
- *Information-processing strategies* make up the largest group of learning strategies. These strategies include developing readiness, reading/viewing for meaning, recalling material, integrating it with prior knowledge, expanding or elaborating on the material, and finally reviewing what has been learned. These strategies seem to correspond to what Merrill (1984) calls "conscious cognition" processes.
- *Study strategies* (in the past been called "study skills") are explicit techniques to help learners actively process information. These consist of such activities as note-taking, outlining, underlining, and the identification and noting of patterns in the new material.
- *Support strategies* relate to the mental climate or attitude at the time of learning, such as the degree the student can internally motivate themself and stay on-task during the instruction. Jonassen (1985) says these last strategies are a sine qua non for learning, and are required in order for the other strategies to be effective.

When many people using both good and poor strategies are averaged in a study, a less-than-ideal picture is painted of the effectiveness of decision-making as a whole. Some researchers suggest that the use of these of these strategies is linked closely with the concept of general intelligence (Snow & Yalow, 1982). It is not unreasonable to imagine that higher ability students might have a greater repertoire of strategies to draw upon when faced with a learning problem. In fact, as Snow and Yalow point out, very often the concept of ability is equated with the capacity of learn.

If indeed we can infer that 1) higher ability students consciously or unconsciously bring to bear the mental resources appropriate to the learning task and avoid using inefficient ones, 2) lower ability students somehow either lack or don't know how or when to activate their learning strategies, and 3) the success of learner-control depends to a large degree on students judiciously applying their mental resources to the learning problem, then we can begin to explain the mixed results of learner-control of instruction as being to a degree a function of learner ability, with higher ability students capitalizing on learner-control and lower ability students left floundering.

An opposing viewpoint that higher ability will predict better learning strategy use comes from Clark (1982). In a review of aptitude-interaction studies he first hypothesizes that high ability students would profit most from activating or cueing methods, that is, techniques which prompt the student to adopt an appropriate mental strategies from their repertoire of strategies for a given problem. Second, he suggests that low ability students would do best under the supplanting or modeling methods, which are techniques which do not rely on the student to use their own mental resources, but rather explicitly guide the student through the optimal learning strategies. But regardless of what they would ***need***, he suggests that high ability students would ***prefer*** to choose supplantation or modeling, while low ability students would ***prefer*** activating or cueing methods. Each group does so because that is the method perceived to be the lowest "mental workload" for the student. In this case, he proposes, neither group selects an appropriate strategy. In support of this hypothesis, one *TICCIT* study (Sasscer & Moore, 1984) found that when students were given the option of terminating the lesson, the dropout rate was related to the types of options chosen. These options patterns were typically the "easier" kinds.

Studies examining learner-control have found some positive associations of ability measures with certain patterns of choice activities in learner-controlled CBI. Snow (1979) found that aptitude measures of fluid-analytic ability and perceptual speed (in addition to a personality variable) predicted the choice activities of successful college students in a BASIC programming task. The best choice activities were described as indicating a reflective and thoughtful style, and were more frequently selected by high ability students. However, the data analysis presented is sketchy, and contains too few subjects to unequivocally trust the multivariate analysis employed.

Carrier et al. (1985) found that between a measure of general ability and a measure of locus-of-control (Rotter, 1966), the best predictor of amount of options selected was the ability measure, with high ability students selecting the most options in the lesson. Additionally, Kinzie et al. (1988) also found that students higher in reading ability selected a high proportion of options to review material than did lower ability students.

There is also evidence that ability helps determine the *kinds* of options chosen rather than the *amount*. Carrier et al. (1986), and Snow (1979) both found near zero correlations between standard ability and achievement measures and *frequency* of choice of instructional options in computer-based concept lessons. Morrison et al. (1992) also report no relationship between amount of instructional support selections made by students under learner-controlled conditions and their posttest performance. Carrier and Williams (1988) found that students choosing *medium* level frequencies of instructional options had the highest ability levels. A study by MacGregor (1988b) also found differences in reading strategies employed between low and high reading ability groups. In contrast, however, Reinking and Schreiner (1985), however, found no differences between low and high reading ability groups in any type of options selected. Examining time spent as presumed indicator of on-line strategies, MacGregor (1988a) compared high and low reading ability groups, and found that higher ability students spent more time when under learner-control conditions than did lower ability students, presumably reflecting the differential utilization of on-line strategies.

A common methodological problem in studies investigating differential options selection is the confounding of ability, pretest performance, and posttest performance. That is, some studies compare options selections between low and high pretest groups (which is frequently correlated with student ability) and low and high posttest groups (also confounded with ability). These surrogate ability measures might limit the inferences one can draw about learning strategy use for ability groups, but still can provide insights useful for further research.

For example, a reanalysis of data presented in Seidel et al. (1975, p. 29, Table 6) shows that while low posttest performers selected overall more options (supporting Clark's (1982) hypothesis mentioned earlier), high performers selected proportionally more of certain types of options, namely QUIZ options, than did low performers; this was not the case for RECAP or REVIEW options available in the lesson. Gay (1986) found high pretest students more "efficient" in their on-line time (this presents a possible contrast to MacGregor, 1988a, where high ability students spent more time).

There is also evidence that ability plays an important role on the attrition of students in large instructional units. An early example, the *TICCIT* system (Merrill, 1973) offered college students a great deal of choice in selection of both content and strategy. Results showed a high dropout rate, but positive results for those who persisted. Those who stayed were generally higher ability students to begin with (O'Shea & Self, 1983, p. 92).

The finding by Tobias (1987a) discussed earlier in the *Prior Knowledge* section, who found the amount of optional review material selected by students positively related to the student's level of pretested knowledge, also might be interpretable as a broader difference in student abilities, as well. However, this confounding of ability and prior knowledge is not universal. For example, neither Holmes et al. (1985) or Rubincam and Olivier (1985) found a relationship between pretest and options chosen.

The mixed results from these studies, while indicating the potential for ability and learning strategies to explain overall performance in learner-controlled CBI, also demonstrate that more research needs to be done. It is likely that the specific type of tasks presented to the students need to be more precisely matched with the specific learning strategies it most corresponds with. Overall ability measures don't have the power to differentiate the more relevant learning strategies adopted by a given student at a given time.

Some types of instructional interventions do appear to work to compensate for the poor use of mental resources in low ability learners. Jonassen (1985) presents several suggestions for improving the use of learning strategies in computer-based instruction in the four categories listed earlier in the *Prior Knowledge* section.

Ability appears to predict, in addition to the individual's perception of need for instructional support (a metacognitive strategy), other types of mental learning strategies in which the student might engage. Although the relationship between ability and choice seems more tenuous than that of prior achievement and choice, there still seems cause to believe that appropriate choice strategies can be made salient to the learners when lacking spontaneously, perhaps via simple instructions or suggestions, and perhaps by changing the attractiveness of the various choices to be made. Additionally, the types of options selected appear more related to ability than quantity of options chosen.

Only one instance was found of a learner-controlled CBI study which attempted to improve students' strategy use. Elementary school students in Jacobson and Thompson's (1975) study were given prompts at various points to help them make appropriate instructional decisions. Although the instructional treatments used in the study were quite large and in may ways not comparable, the authors still conclude that such strategic prompting can help students to make appropriate decisions. Reigeluth (1979) proposes that learner-controlled instruction offer students an "advisor" option, a sort of prescriptive "help" feature, which would suggest to the student various so-called "optimal" strategies for how to process information or what to do next in the lesson. The potential flaw in this proposal is that students might not know how or when to access the advisor. Another intervention system is proposed by Allen and Merrill (1985), which provides to the learners varying amounts of learning strategy suggestions depending on their aptitudes for accomplishing the learning tasks. For students of low abilities, for example, the computer would provide explicit processing representations for the students to follow; for medium ability students, the system would "guide" the learner to use certain previously learned strategies; high ability students would be left with the most freedom to select and apply their previously acquired processing strategies without external suggestions or interference from the computer system. This type of system has not yet been tested.

The idea behind all these approaches is to promote the conscientious and mindful use of instructional options according to individual needs for instructional support. The following section shifts the examination of the rational predictors of learner choices to the emotional or affective predictors.

Emotional-motivational aspects of choice and learning

"Motivation" is a very slippery concept. J.M. Keller (1983) defines motivation as the "magnitude and direction of behavior. In other words, it refers to the choices people make as to what experiences they will approach or avoid, and the degree of effort they will exert in that respect" (p. 389). Both intuition and research (Tobias, 1987b) inform us that poorly motivated students are also very often poor performers in educational settings, too. However, the derivation of instructional prescriptions to help students improve their motivation to learn requires a much more detailed exploration of both the determinants of motivated behavior, and the effects of motivation on choice and learning. That is, we need to uncover the reasons (motives) behind particular choices a student may make, to clarify which variables determine, or at least predict, both general patterns and levels of choice and situation specific choices students will make. Additionally, we need to investigate the relationship between motivation and learning. In path analytic terms, both direct and indirect (via the actual instructional choices made) relationships of motivation and learning require clarification.

A terminology issue needs to be raised at this point. Many researchers would argue that a "motivated" behavior might be based on rational, logical decision-making processes, and thus is not best described in terms of "emotional-motivational" processes. This is true to a large extent (although some could argue it is moot). However, for clarity sake in this paper, learner "motivation" refers largely to the emotional states and reactions (and their consequent overt behaviors) experienced before, during, and after instruction which have an impact on learning and choice. So-called "rationally" motivated behaviors were discussed earlier in this paper.

A large body of research and several psychological theories exist which attempt to describe and explain the relationships among emotional-motivational variables, choice, and learning, and will only be touched upon here. Instead, the implications of these findings about motivation and learning for the design of learner-controlled instruction will be explored.

1. Achievement motivation and learner-controlled instruction. The history of motivation research contains a sizable body of literature concerning what is called "achievement motivation," in simple terms, a person's desire to perform and achieve. Because of the behaviorist tradition from which the concept sprang, authors on the topic have tended to present "motivation" as a fairly broad and inclusive construct defined by overt behaviors such as persistence and perseverance, and have tended to not investigate the specific underlying emotional states which could be said to be the sources for such achievement-related behaviors. Nevertheless, their research is still very relevant in our discussion of learner-controlled instruction and deserves exploration. Discussion of learner motivation in terms of the emotional states experienced by the learner will follow in the next section.

Following this tradition, Lepper (1985) suggests that motivational factors could operate on learning under learner-controlled computer-based instruction in two possible ways. First, students' simple exposure to instructional materials and time-on-task will vary according to their motivation to choose. That is, the often repeated failure to demonstrate the effectiveness of learner-control might simply be a function of the fact that less instructional material is selected by those students, hence they received an "incomplete" lesson compared with their program-controlled counterparts. In other words, learner-control ineffectiveness would be totally unrelated to the learner's emotional or motivational states or tendencies, and would be more an artifact of the particular set of instructional events they experienced (or more likely, did not experience). This is a similar argument to that given earlier in the section on *Prior Knowledge*.

Indeed, Ross and Rakow (1981), Tennyson et al. (1980), Tennyson (1980), and Tennyson and Buttrey (1980) all showed that students in the learner-controlled treatments saw many fewer instructional examples than did students under program-control. The sheer result of pooling students seeing both low and high amounts of instructional material would certainly be expeected to show lower overall scores than students only given high amounts of instruction.

However, in these studies, effects of the amount of material seen were confounded with the treatment, learner or program-control. That is, lower amounts of instructional material were inextricably linked to the learner-control treatments. Carrier and Williams (1988) experimentally controlled the amount of material seen, and found a positive effect for amount of material separate from learner-or program-control effects. In a study by Morrision et al. (1992), amount of instructional material was controlled for by having two program-controlled versions: one with "minimum" instructional support, one with "maximum." They found that the students under learner-control actually performed poorer than those with the "minimum" program-control treatment.

A second link between motivation and achievement, says Lepper (1985), is more direct and related to covert states in the learner. It is possible that a person's level of motivation during the performance of a learning task affects key components of information processing related to learning, a position also taken by Salomon (1983). Emotional-motivational variables may influence the direction and intensity of attention processes, arousal, depth of processing, and problem representation. Even though Lepper (1985) points out that many of these information processing ideas are at present hypothetical, there does seem to be an emerging unification of the underlying mechanisms linking motivation and achievement (Humphreys & Revelle, 1984).

Some motivation researchers (J.W. Atkinson, 1974b; Brophy, 1983; J.M Keller, 1983) posit a curvilinear (inverted U-shape) association between student motivation level and learning. That is, both very low and very high motivational levels can have dysfunctional effects on learning.

Given this relationship it would be interesting to look for interactions of level of motivation and learner- or program-controlled instructional treatments. Such an ATI has been found by Carrier and Williams (1988). Using task persistence as the overt motivational index, they found that under two program-controlled treatments (with low and high amounts of instruction) students performing best were those in the *middle* levels of persistence; under learner-control, the best performers had the *highest* levels of persistence. In other words, the curvilinear relation between motivation and learning was found under program-control, but a mostly linear relationship was found under learner-control. (Similar data was collected in a study by Morrision et al., 1992; however, they only reported on the linear relationship --none-- between task persistence and achievement. It would be interesting to reanalyze their data to see if such a curvilinear relationship emerges.)

A possible explanation for these differential treatment effects can be inferred from a paper by Humphreys and Revelle (1984). Following their theory describing the underlying relationships between effort and performance, it is speculated that students behaved as though learner-control was an easier or less complex condition; i.e., it placed fewer demands on their learning resources. Alternatively, the learner-controlled treatment produced less overall anxiety which could have interfered with learning. This interpretation is also consistent with Salomon's (1983) general notion of "perceived demand characteristics" of instructional treatments.

Although still hypothetical, three instructional factors are proposed here which might be expected to interact with a person's average general level of achievement motivation: learner or program-control; task complexity; and extrinsic motivation variables.

Learner- and program-controlled treatments might be perceived by different students to be easier or more difficult to manage. It is possible that general motivational level could have an influence on performance by interacting with these treatments in a linear or curvilinear fashion, depending on the perceived "ease" of learning under the treatment.

Second, fairly simple tasks given under both learner and program-controlled treatments might find no differences for highly motivated students. However, for difficult tasks, or those tasks requiring careful and deliberate thinking, one might expect learner-control to surpass program-control, at least for highly motivated (persistent) students. It is not clear yet what to expect for students of low or middle levels of motivation under tasks of varying difficulty or complexity.

Last, the object of using extrinsic motivators would be to try to increase the learner's persistence or effort expenditure, particularly for those students with low motivation levels, through instructional manipulations. J.W. Atkinson (1974a) lists as examples of extrinsic motivators authority, competition, social approval, and external rewards. Three studies from the learner-control literature support the use of these extrinsic motivators. Tennyson and Buttrey (1980) and Tennyson (1981) found that providing students under learner-control with *advisements*, that is instructional recommendations about whether they should select more material (based upon a mastery diagnosis) did result in higher amounts of material chosen and in learning equivalent to the program-controlled version. Similarly, Carrier et al. (1986) found that encouragements within a learner-controlled treatment did increase the amount of material chosen by the students over a learner-controlled treatment without encouragements. There is evidence, then, that simple instructional guidance can alter the overall level of task persistence and other on-task behaviors.

One broad prescriptive framework for the general improvement of student motivation comes from J.M. Keller (1983, 1987a, 1987b). He presents a well integrated model, which subsumes much of the previous discussion, for the design of motivating instruction which offers prescriptions consistent with the previously mentioned basic research on learner motivation.

2. *Emotional-motivational patterns and learner-controlled CBI.* The remainder of this section attempts to peer beneath the overt motivational variables (e.g., persistence) to see how learner emotional states might have direct or indirect impacts on learner-control effectiveness. Dweck (1986) and Dweck and Leggett (1988) offer a useful integrative approach to understanding student behaviors in terms of the student's own internal beliefs about the nature of their performances and their striving to confirm those beliefs. In their model, students are continually forming implicit theories about themselves which orient them to seek particular goals related to confirming these theories. Dweck (1986) describes so-called *adaptive* (or "mastery-oriented") and *maladaptive* ("helpless") motivational

patterns. The maladaptive pattern is characterized by an avoidance of challenge and a deterioration of performance in the face of obstacles. Students who exhibit an adaptive pattern, in contrast, tend to seek challenging tasks and the maintenance of effective perserverance under failure circumstances.

What follows is an example of *one* avenue of promising theory, to date fairly unresearched withiin CBI contexts, which holds promise for explaining the heretofore mixed effects of learner-controlled CBI, and suggesting means of improving instructional designs which adopt learner-control. The investigation of other theoretical frameworks is encouraged, as well. In all cases, however, the idea is to try to understand the nature of emotional states the learner experiences which produce healthy (*adaptive*) or dysfunctional (*maladaptive*) expression in terms of choices, persistence, and perseverance during learner-controlled instruction.

A major portion of Dweck and Leggett's (1988) model is based on research in the area of student *attributions* of their success and failures. Here the conception of motivation becomes that of a somewhat unstable factor affected on a moment-by-moment basis by the person's perception of events happening during instruction and their own inferred role in those events. Generally, an "attribution" refers to an individual's perceived causes of their own success or failures. Early conceptualization by Kukla (1978) and Weiner (1974) explain that the degree to which a person ascribes the causes of their own success or failures to ability, effort, task difficulty, or luck will differentially predict whether or what kinds of subsequent performance opportunities the student is likely to voluntarily select. These four variables can be grouped along two primary dimensions: internal versus external (analogous to, but not the same as the familiar "locus of control" dimension of Rotter, 1966); and stable versus unstable.

Other researchers have recently extended, refined and reconceptualized attribution theory. For example, Covington and Omelich (1984a, 1984b, 1985) attempt to frame student attributions in terms of emotional states they imply such as pride, shame, guilt, and humiliation. Additionally, Dweck and Leggett (1988) present a model which seeks to explain the precursors of an individual's attributions along the "controllability" dimension. That is, they attempt to explain why some individuals feel more in control of their performances outcomes and others feel more "helpless." These developments in attribution theory have potentially important consequences for the design of motivational interventions during instruction.

Very few studies have explicitly examined attribution-like variables in connection with learner-controlled CBI. Treating perception of internality/ externality of reinforcement (or "locus of control," Rotter, 1966) as a predictor variable has yielded generally unimpressive results in differentially predicting learning under several instructional conditions (Tobias, 1987b) and in predicting overall choice levels or learning in learner-controlled instruction (Carrier et al., 1985, 1986; Gray, 1989; Hannafin, 1984; Klein & Keller, 1990; Santiago & Okey, 1992). In fact, López and Harper (1989) conclude that there is little to be gained by further research investigating Rotter's locus-of-control construct in connection with learner-controlled instruction. Nevertheless, these negative findings could be masking potentially valid discriminations within groups broadly labeled externals or internals. For example, the differences between the two internal attribution styles, ability and effort, might be expected to affect options selection in either adaptive or maladaptive ways.

One early study (Fisher et al., 1976) treated various attributional variables as dependent variables under conditions of learner- and program-controlled problem selection. The authors found that subjects in the choice group made significantly more internal and stable attributions during or following instruction than did students in the program-controlled group. They also found no treatment differences for an attribution variable they called "control-no control;" but they do not provide an operational definition of this variable to aid interpretation. Additionally, even though these researchers did not take baseline measures of attribution, nor plot the changes in attributions occurring over time, their study still supports the short-term modifiability of attributions as a possible result of treatment variables.

Within J.M. Keller's *ARCS* model (1983, 1987a, 1987b), both attribution theory and learner-control would potentially play a useful roles when attempting to improve student *Confidence*. In some strategies, Keller suggests, students might receive attributional feedback to enhance the feeling of that "they can do it." Additionally, they could be given some degree of control over their learning situation to enhance feelings of their own self-efficacy. The attributional feedback would seem to apply mostly to situations under learner-control where students are asked to choose performance-related options. These options could include the selection of such specific instructional events as optional practice items, feedback, test situations, and possibly remediation or review following test conditions.

However, J.M. Keller's model is fairly non-specific about the types of attributional feedback which should be offered to students, and under which circumstances it would function optimally. Milheim and Martin (1991), too, suggest the utility of attribution theory for explaining the mixed effects found in the learner-control literature, but they, too, offer few specific suggestions for possible instructional design strategies which incorporate the theory.

Manipulations directed toward attaining these treatment goals would seem to fall into three classes of instructional strategies: 1) those affecting an entire lesson condition; 2) those preceding specific choice situations, taking the form of guidance, advice, or recommendations; and 3) those immediately following performance situations, taking the form of interpretations and attributions of success or failure generated by instruction.

In the first strategy class are included attempts to adapt instruction to whatever overall attributional style a person seems to possess. Here, diagnosis of attribution levels would take place once, prior to the start of the lesson. All instruction might by subsequently modified accordingly in the manner of an ATI.

Additionally in this class, instruction could at the outset inform the learner that they have control over what they see, and that their performance will be determined by how much they try. Given this, it would be necessary that the instruction monitor performance throughout the lesson and adjust task difficulty so as to minimize the discouraging effects of frequent failure.

Also in this class are manipulations related to task- or ego-involvement, as described earlier. Suggestions of norm-referencing (ego-involvement) could accompany students with high success rates. Examples would be general statements that a student's performance will be compared to others, or perhaps comments to the students that they did better than most people on a particular task. Low performing students might be best placed under task-involved conditions which encourage value placed on task improvement.

The second class also subscribes to a typical adaptive instruction paradigm, although here we are dealing with micro-instructional adaptations of task-specific attributions. In particular, strategies in this class are forward-looking, and include encouragement and advisement techniques such as those mentioned in the earlier section on achievement motivation. Some specific techniques might include recommending to the student they choose a task of hard (medium, easy) difficulty level depending upon what the student's current performance level and attributional tendencies are at the moment. They might also include such motivating statements such as "try harder on this one ...," or "the next task is an easy one ..." Another possibility might be to describe a subsequent task in terms compatible with the student's attributional style, but again on a very local level.

In the last class of instructional manipulations, the instruction could make evaluative and interpretive comments on a student's performance immediately following the success or failure of the task. The goal of these reflective or backward-looking instructional strategies is to intentionally alter attributions. Comments to the student might attribute failure to not trying hard enough, or when appropriate, to a task being difficult. Successful performance would always be attributed by the instruction to an internal factor. A study by Carrier et al. (1986) gave students a variety of backward-looking encouraging feedback (though not attributionally related) and found positive effects for task persistence. It is expected that feedback engineered more specifically to counteract maladaptive attributional patterns in the students would be even more fruitful.

A doctoral dissertation conducted by this author (Williams, 1992), examined the impact of attributionally related feedback on learners of differing attributional tendencies (or styles) within learner- and program- controlled conditions. The type of feedback employed in the study was specifically intended to affect a student's temporary perceptions of the causes of their learning successes and failures, that is their *attributions* of their performance outcomes, so to minimize the dysfunctional behaviors of learners with maladaptive attributional styles. Providing specific attributionally-related feedback to learners in an attempt to temporarily alter attributions has a well-established research base (Andrews & Debus, 1978; Barker & Graham, 1987; Borkowski, Weyhing, & Carr, 1988; Dweck, 1975; Fowler & Peterson, 1981; Graham & Barker, 1990; Medway & Venino, 1982; Meyer and Dyck, 1986; Schunk, 1982, 1983, 1990a; Schunk & Cox, 1986) which had hitherto not been investigated in a computer-based context.

Findings from the study generally support the notion that, overall, certain types of attributional styles are maladaptive. That is, students who exhibit such motivational patterns tend not to exert as much effort or mental investment in their learning activities, and thus are prone to perform poorly.

Additionally found in the study, the granting of a relatively small degree of learner-control within the CBI lesson succeeded in improving the performance of students who otherwise showed certain types of maladaptive motivational patterns. Also, students showing one type of generally maladaptive attributional style showed markedly improved performance when given such feedback following their on-task performances. In other words, giving attributional feedback moderated the maladaptive tendencies of these students.

A final finding from the study is more complex, but still interesting. Within program-controlled conditions, the inclusion of attributional feedback had the effect of improving learning for who normally exhibit dysfunctional attributional styles, but providing such feedback seems to have a deleterious effect on those who otherwise had functional attributional styles. Attributional feedback given to student under learner-control showed no such interactive effects; that is, students classed as having maladaptive styles performed, as expected, poorly and those with functional attributional styles performed well.

To summarize, the previous section posits that the general ineffectiveness of learner-controlled CBI can be explained, at least in part, by the fact that some learners have acquired maladaptive motivational tendencies, and as a result exhibit dysfunctional or suboptimal choices (e.g., showing low persistence or perseverance or terminating a lesson early). There is some evidence, although scant, that one particular motivational theory, namely attribution theory, can be exploited to improve the on-task motivational behaviors for learners within learner-controlled situations. The goal is to increase both motivation to achieve where such motivation is low and motivational patterns are maladaptive, and to help the student to optimize their selection of instructional support.

Summary

This paper has reviewed many studies comparing various forms of learner-controlled computer-based instruction with program-controlled CBI. These studies had been theoretically predicted to show learner-control superior to program-control. However, empirical findings related to these predictions have been disappointing.

A closer examination of these studies showed that a number of mediating factors were likely responsible for the poor performance under learner-control. It was found that many students simply were not capable of making good use of the control they were given. Two large categories of individual difference variables were suggested to be important in identifying these students: rationally-cognitively oriented variables and emotional-motivational variables.

In particular, both student prior knowledge and ability were found to predict student success under learner-control. Prior knowledge was found to be related to the capacity of the students to estimate the amount of instructional support they would need. (Students with low amounts of knowledge were not able to effectively monitor their comprehension.) Additionally, student ability was viewed as related to the learning strategies individual students bring to bear when faced with a learning problem. (Low ability students typically do not have the repertoire of learning strategies available to them that higher ability students do.) Some suggestions were offered for accommodating these differences within learner-controlled instruction.

The student's level of motivation was also found to be a potentially important variable in explaining the overall effects of learner-control. In particular, attributional theory was offered as an example of a well-grounded framework for understanding motivated student behaviors and effort and for adapting instruction to meet the needs of students with maladaptive attributional patterns.

In addition, this paper supports the utility of the adaptive instruction paradigm of Gehlbach (1979). In this framework, unlike the classic ATI approach of Cronbach and Snow (1977), students who are deficient in some relevant aptitude are administered an instructional treatment intended to "correct" the difficulty, not accommodate it. In the current case, students who exhibit suboptimal motivational patterns are provided with appropriate feedback in an attempt to encourage more healthy emotional self-perceptions and hence more functional behaviors.

Recommendations for future research

I believe it is now time to stop asking the research question "which is better: learner- or program-controlled CBI?" It seems that enough research has been produced to date to justify the conclusion of "take your pick." Rather, I would like to suggest that future researchers fundamentally alter the question to read, "How can I make learner-controlled CBI effective?" A study by Santiago and Okey (1992) which investigated various forms of advisement conditions all under learner-control provides a good example of how research might be conducted with the aim of improving learner-controlled instruction. Other specific issues which might be pursued include the following:

1. What specific instructional events are most or least amenable to providing or withdrawing learner-control? That is, of the many instructional strategies, methods, activities, and events from which designers may draw upon to build lesson designs, which ones are most promising? Theoretical work by Laurillard (1987), Milheim and Martin (1991), and Steinberg (1989) go a long way toward providing prescriptive guidelines for designers; however, more specific recommendations need to be explored. I would also like to strongly concur with Milheim and Martin's (1991) suggestion to conduct more empirical and theoretical work on the nature and role of learner motivations in learner-controlled CBI settings.

2. What exactly is the nature of a learner's mental processes as he or she proceeds through learner-controlled instruction? If we can better understand both the rational-cognitive thought processes and the emotional-motivational states of the learner, we might be able to devise means to encourage optimal processes and perhaps attempt to alter or at least compensate for dysfunctional processes. This type of investigation has been suggested before (Clark, 1984; Robson, Steward, & Whitfield, 1988) but has not yet been adequately pursued, perhaps because of the inherently qualitative nature of the data and the lack of comfort with such methodologies by learner-control investigators.

3. Related to the previous suggestion, it is time investigators more closely examined the social nature of learner-controlled activities. Anyone who has observed classroom situations where students navigate through instruction has informally noticed that there can be a great deal of discussion between students, both sitting at separate computers and working at the same computer. Rather than attempt to eliminate such interactions in order to investigate the "pure" effects of learner- or program-control, researchers may wish to adopt methodologies closer to field-studies or naturalistic inquiry to study how learners can feed off each other during instruction.

4. Learner-control should be much more closely investigated under other common or developing types of computer-based environments, such as: simulations; hypermedia and other online databases (such as electronic encyclopedias); online help and other support tools; and distance education. All of these contexts (possibly excepting distance education), by definition, intrinsically allow learner-control to a greater or lesser degree. And it is likely that these types of computer-based experiences will soon be more frequent experiences for students than standard tutorials. However, very little research has been conducted to sort out the peculiar learner-control factors in each which need attention or support.

5. There needs to be a greater link make between learner-controlled CBI research and a growing body of literature on the topic of *self-regulated learning*. Briefly, this research, developed by

McCombs and associates (McCombs, 1982, 1984; McCombs & Marzano, 1990) and by Zimmerman and associates (Zimmerman, 1990; Zimmerman & Martinez-Pons, 1986, 1988, 1990), conceptualizes students as "metacognitively, motivationally, and behaviorally active participants in their own learning processes" (Zimmerman & Martinez-Pons, 1988, p. 284). Although the research so far has primarily focused on understanding on a rather macro level the mental strategies occurring during successful self-regulated learning, this literature has clear implications for the inclusion of motivational variables in the design of learner-controlled instructional systems. In fact, some investigators have recently begun to explicitly address motivational variables operating in self-regulated learners (e.g., Schunk, 1990b; Zimmerman & Martinez-Pons, 1990). Additionally, there is beginning to emerge an interest in the application of self-regulated learning models to other formats of CBI, such as computer programming (Armstrong, 1989).

Conclusion

Lepper and Chabay (1985) succinctly summarize the problem of differentially providing learners with control over their own instruction, "It is unlikely that any choice of level of control will be optimal for all students, or even that the same level of control will be optimal for a single student for all activities or in all situations" (p. 226). Of the many approaches for accommodating differences among learners, one is to allow them to adapt the instruction themselves to meet their own needs as they see fit. Instruction would not be linear and lockstep; that is, all students could receive different instructional events. This strategy is not as highly prescriptive or determined or complicated as branching or other adaptive schemes sometimes found in computer-based approaches. Rather, learner-control is a way of allowing individual differences to exert a positive influence without trainer control or intervention based on these individual differences. However, great care needs to be exercised by designers in constructing their learner-controlled lessons to optimize effectiveness for *all* types of learners.

In sum, after all that has been written about the virtues of giving trainees control over their own learning, such activities alone offers no guarantee of successful learning. This might have been forecast by Dewey, that strong proponent of experiential education, who voiced concerns about unconditional learner self-management, "The ideal aim of education is creation of the power of self-control. But the mere removal of external control is no guarantee for the production of self-control." (1938, p. 64).

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Title:

Tracking and Analyzing Learner-Computer Interaction

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Introduction

The last twenty-five or so years have shown an explosion of research and development in computer-assisted and computer-managed learning environments. Academics investigating the nature of the learner-computer interaction, as well as software producers interested in developing higher quality, response-sensitive computer-based learning tools, have been seeking more and better means of collecting, managing, and analyzing the particular responses students make during their time at the computer keyboard.

When a learner interacts with instructional software, a complex set of processes takes place. Capturing this rich data for study is important if we are to advance the art and science of CBI design. But as the research questions have become more complex, there has also come a proliferation of options for data collection and analysis in these environments (Johnson, 1982).

The reasons for wishing to monitor student responses during instruction are myriad. Misanchuk and Schwier (1992) discuss four categories of reasons for wishing to collect data about online learner responses. The first category is for *formative evaluation in instructional design*. For example, software developers in an *alpha* testing phase of product creation are often interested to discover which features of the software could be streamlined or eliminated. Thus, for example, they may wish to trace the frequency or occasions when students access "help" screens or, maybe, how often students return to main menus.

A second category relates to *basic research in instructional design*. For example, basic researchers such as Clark (1984) suggest the need to try to determine precisely what students are thinking as they progress through computer-mediated learning systems in order to produce more efficient or effective instructional designs.

A third reason discussed by Misanchuk and Schwier (1992) is to collect such data for *usage audits for unstructured or public environments*. The purpose here is to unobtrusively peer "over the shoulders of of groups of users to determine how they are traversing the interactive media package." This use of online response data combines characteristics of both of the first two reasons mentioned above.

Last, learner-computer interaction data might be used for *counselling and advising* purposes. That is, data from such interactions can be collected into databanks and analyzed with the intention of informing the learner of their relative skills, knowledge, learning styles, and so on. The idea is to involve the learner as a full partner in instructional decision-making.

But whether the investigator is a software developer concerned with the formative evaluation or the rapid prototyping of a new product, or is a researcher exploring the whys and wherefores of student responses during CBI, there is a clear need to have a toolkit of data collection and analysis techniques which can provide an accurate and useful record of student navigation routes.

This paper builds on the work of Misanchuk and Schwier (1992) by detailing some specific computer-based tools for collecting and examining what they call "audit trails," that is, data which describe a learner's path through a CBI lesson. (Incidentally, the term "audit trail" was also found in a remarkable early paper by Grubb, 1968, who presents a computer-based instructional system which in many respects presages the current hypermedia systems.) Additionally, data analysis and measurement issues relating to the use of data from these audit trails are also discussed.

Essential User Information to be Captured

If we are to track a learner's path through a piece of software, what kinds of data are important? In a graphic user interface (GUI) environment, the kind used most often today, there are three major categories of useful data which determine the learner's path through a computer experience:

1. ...the identity of each user interaction with the software. This information answers the question, "*What action* did the student take?" and may include:
   - mouse clicks on buttons, fields and cards
   - responses typed into the keyboard
   - menus pulled down

2. ...the specific screen location of each mouse event. This data answers the question, "*Where* did the action take place." and includes:
   - where the mouse was clicked
   - where the cursor was when the mouse button was released

3. ...the time at which each learner interaction occurred. From this data can be calculated any specific instance of what is sometimes called "latency," that is, the time spent between actions of the learner. The time taken to understand a screen or to answer a question can be used to study the learner's cognitive processing (e.g., see the work of Tennyson and associates).

In journalistic terms, these *What, Where* and *When* of learner actions will also be important to track in the new pen-based interfaces as they emerge. A few years from now, when voice-based interfaces become more common, the *What* and *When* factors will continue to be of interest to researchers and designers while the *Where* will become less relevant.

What follows is an in-depth presentation of a particular set of embedded computer-based tools currently being used at San Diego State University which assess the *What, Where* and *When* data types. Although the programming statements are idiosyncratic to the particular software used, the programming constructs represented are generalizable to other platforms and authoring systems, as well.

Structure of HyperCard

The examples that follow are developed in HyperCard, a tool-building environment for the Macintosh computer. Programming of a similar type could be done in any graphic-oriented environment on any platform, including Authorware, Plus, Director, ToolBook, and SuperCard. To clarify the descriptions of programming logic, some explanation of HyperCard's structure may be useful.

HyperCard is used to create *stacks* which are collections of individual *cards*. Cards can share common backgrounds and can contain *buttons* (active areas of the screen which can respond to input from the mouse) or *fields* (areas of the screen holding text, which can also respond to mouse or keyboard input). Stacks, cards, backgrounds, buttons and fields are collectively known as *objects*, and any object can contain a *script* or program consisting of one or more *handlers*. Each handler handles events as they occur, such as the click of a mouse within the boundaries of a button, or the pressing of the Enter key within a field.

Programming in HyperCard is oriented around these objects. Unlike some environments in which the intelligence is contained in a single program listed all in one place, a HyperCard stack can contain many programs in the form of handlers within individual buttons, fields and cards. The handlers for tracking learner actions are described in the next section.

Explanation of the Handlers

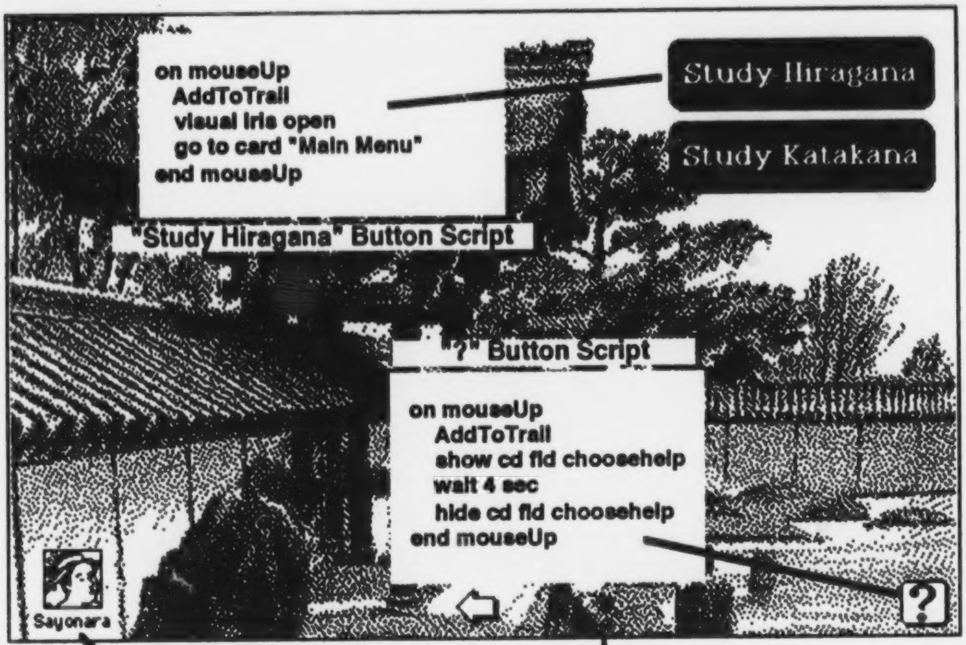
There are four major handlers needed to track learner actions in a HyperCard stack:

- *StartTrail* - initializes the trail variable which stores each action
- *AddToTrail* - adds a specific event to the trail
- *SaveTrailFile* - saves the trail variable to disk
- *ShowTrail* - shows all mouseclicks accumulated in a given trail file

Each of these is described in more detail below. The ShowTrail handler is discussed within the section on analysis options.

StartTrail. HyperCard makes use of global variables to store information while a stack is executing. Global variables retain their values anywhere in a stack, even across stacks, until the user quits the HyperCard application. Because the variable exists in random access memory, writing to it is quick enough to be practically undetectable. This allows the program to track user actions without slowing down the stack noticeably. In this instance, the startTrail handler sets up a global variable called "Trail". This variable contains separate lines of data for each learner action, and begins with a header consisting of bullets (•) to mark the beginning of a new run of the stack. This header is followed by a line containing the starting time and date on which the stack was run.

AddToTrail. Once the Trail variable has been set up, this handler stores data about each learner action. It is called up by including the name of the handler in the script of every button, field, and background in the stack. The illustration below shows how this might be done on a sample card:



```
on mouseUp
  AddToTrail
  visual iris open
  go to card "Main Menu"
end mouseUp
```

"Study Hiragana" Button Script

"?" Button Script

```
on mouseUp
  AddToTrail
  show cd fld choosehelp
  wait 4 sec
  hide cd fld choosehelp
end mouseUp
```

```
on mouseUp
  AddToTrail
  visual checkerboard slow
  go cd credits
end mouseUp
```

"Sayonara" Button Script

```
on mouseUp
  AddToTrail
end mouseUp
```

Background Script

SaveTrailFile. When the stack is closed, this handler takes the Trail variable from memory, adds the end time and total elapsed time, and stores it in a text file on disk.

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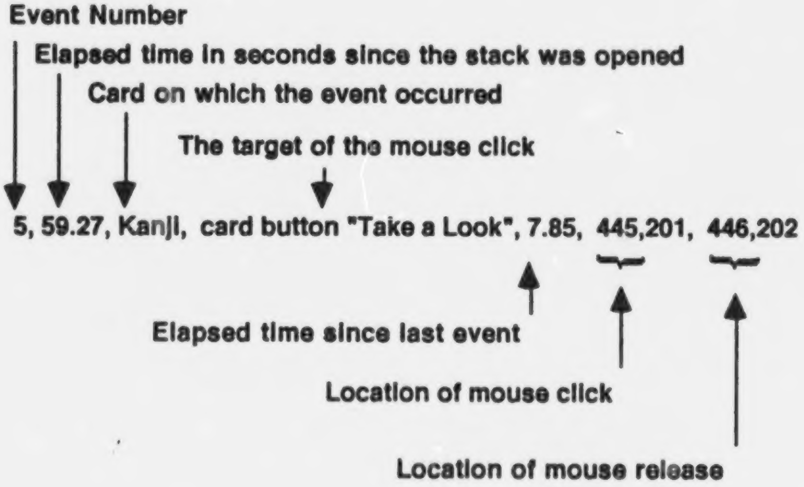
Sample Audit Trail

All of these handlers work together to create a record of learner actions stored on disk for later analysis. Here is a short sample trail:

```
••••••
Stack opened at 8:25:25 AM on Saturday, January 9, 1993

1,29.53,card id 109271,card button "Next",29.53,255,311,259,313,
2,33.18,Choice,card button "Study Hiragana",3.65,397,39,397,39,
3,42.53,Main Menu,card button "        Historical Stuff",9.35,394,59,397,62,
4,51.42,Historical,card button "Take a Look",8.88,447,202,447,204,
5,59.27,Kanji,card button "Take a Look",7.85,445,201,446,202,
6,62.33,Historical,bkgnd button "Menu",3.07,43,283,45,287,
7,65.38,Main Menu,card button "     Outta Here",3.05,371,239,371,239,
8,68.35,Choice,card button "Sayonara",2.97,40,305,54,300,
9,90.77,Last Card,card button "Quit",22.42,371,203,370,203,
10.00,90.90,Last Card,card button "Quit",0.13,371,203,363,203,Menu item: quit hypercard
Stack closed at 8:26:56 AM
Total elapsed time = 91.20 seconds
ΩΩΩΩΩΩ
```

This trail represents a very short run of the stack in which the learner passed through 6 different cards and clicked on 9 buttons to navigate among them. Each mouse click, menu operation, or keyboard input is stored as a single line in the trail, with each part of the data separated by commas.


Event Number
Elapsed time in seconds since the stack was opened
Card on which the event occurred
The target of the mouse click
5, 59.27, Kanji, card button "Take a Look", 7.85, 445,201, 446,202
Elapsed time since last event
Location of mouse click
Location of mouse release

Analyses of Audit Trails

The investigator has many decisions to make about what to do with the data from audit trails of student responses. This section will suggest methods which can help to make sense of the often times overwhelming volume of data generated.

As can be seen from the previous section on how to collect audit trails, if the investigator wishes to collect enough information to completely determine each student's path, actions, and time spent, the number of data points generated from a typical computer lesson can quickly run into the hundreds or thousands for just *one* student! Misanchuk and Schwier (1992), too, point out, audit trail data collected from multimedia/ hypermedia lesson structures can be extremely difficult to make sense of. This is because data for individual students are voluminous and data between students do not have a consistent or parallel format amenable to standard spreadsheet-oriented data analysis tools (including most commercial statistical packages, such as SPSS and SAS). Rarely is the investigator able to use, without convoluted data transformations, such standard statistical tools as repeated measures or time series analyses. Too often the volume of variables or the frequency of contingent missing data (that is, not all students experience the same instructional events) prevent adequate statistical interpretation of the data.

As it turns out, there is no "right" way to interpret such data. In general, though, there is one trade-off the investigator must make early in the data analysis process which will guide subsequent analyses: analyzing the intact data in its original and complete format, or analyzing the data which has been aggregated into summary, averaged, or otherwise collapsed variables. Finally, some pertinent measurement issues will be discussed.

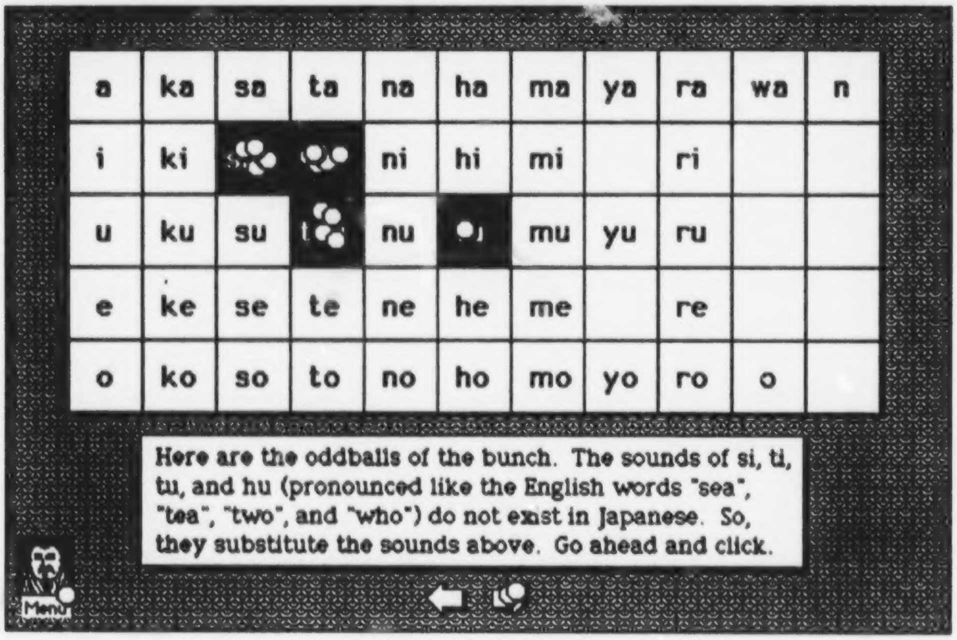
Qualitative analyses of original (non-aggregated) data

One option for investigators is to not even attempt to aggregate the data into reduced sets of records and variables. Indeed, there are many instances when investigators might wish to forego statistical analysis of audit trail data altogether. For example, instructional developers may wish to look at the data record from a manageably small sample of individual students to boost the validity of a formative evaluation. (A small *n* is usually required for such analyses because there are seldom enough resources available to conduct analyses on a large number of students.)

Additionally, researchers may want to adopt qualitative methods to examine each student's path up close. The idea (though far from simple or easy) is to search a fairly small number of audit trails for clues and patterns which might elucidate some phenomenon of interest connected with the lesson or the student. For example, this approach could unobtrusively give researchers valuable insight into a student's thought processes as they proceed through some lesson (e.g., Robson, Steward, & Whitfield, 1988). The challenge, of course, is maintain methodological rigor so that interpretations of individual audit trail data will be reasonably unbiased, and that findings can be validly generalized beyond the small sample involved. Many good sources exist which present techniques for qualitative data analysis of data such as this, so such techniques will not be covered here.

Rather than attempting to interpret student responses by simply staring at the audit trail output file, investigators are perhaps better served by, if possible, "replaying" the lesson so to experience the CBI just as the learner did. The following example illustrates just such an audit trail playback routine.

Illustration. The ShowTrail handler was developed to represent visually the history of mouse clicks recorded for one or more users of a stack. It takes a trial file, parses it, and places a round button on the location of every mouse click stored.



a	ka	sa	ta	na	ha	ma	ya	ra	wa	n
i	ki			ni	hi	mi		ri		
u	ku	su		nu		mu	yu	ru		
e	ke	se	te	ne	he	me		re		
o	ko	so	to	no	ho	mo	yo	ro	o	

Here are the oddballs of the bunch. The sounds of si, ti, tu, and hu (pronounced like the English words "sea", "tea", "two", and "who") do not exist in Japanese. So, they substitute the sounds above. Go ahead and click.

This allows one to see several things at a glance:

- Which buttons were clicked most often, least often
- Which items on the screen were misinterpreted to be buttons and were clicked on with no result
- What *part* of a button was clicked on.

In the example above, each button triggers a sound file so that the learner can hear the pronunciation of a syllable. The sounds on the buttons on the left are harder for the American ear to distinguish, and were thus clicked more often than the button playing the "hu" sound. In addition one can see that one learner left the sequence at this point to return to the menu, while the others clicked the forward arrow to continue.

Quantitative analyses of aggregated data

When data trails are involved from large numbers of students, it may not be feasible for the investigator to closely examine each student's record. In these cases, the investigator might want to collapse data into simpler categories or variables for analysis. For example, the investigator might want to average the student's time spent over only a few types of events; or perhaps simply count the number of times the student returns to, say, a review section of a lesson. These kind of aggregated data are much more amenable to statistical analysis, in that only a few variables are created and examined, and there are substantial numbers of students with data to provide statistical power. The trade-off here is that, whenever data are collapsed, information is lost. That is, the *unique* profile of each student's set of responses becomes lost in the aggregation process, and with it some potentially useful insight.

(Certainly, there are many instances when such aggregated data might be interpreted qualitatively, as in the previous discussion. However, it is recommended here that aggregated data are most useful when analyzed statistically, on a sample large enough to provide adequate statistical power.)

Types of variables. When examining aggregated data, the investigator usually has an agenda of research questions which will presumably be addressed by the data. Operationalizing these questions, however, is not a trivial matter because of the wide range of experiences students typically experience during hypermedia CBI. That is, the interpretations we might give to certain data points from one student might be different from the interpretations we give to another student on those same data points. Ignoring the *span* of each student's experiences might result in invalid conclusions about what occurred during the lesson.

Once the specific variables are decided upon, the researcher needs to decide which data points are to be included in the aggregated cases and variables. For example, say there is an embedded quiz which all students must complete. It is a fairly simple matter to aggregate these data and analyze them according to the research questions of interest. The same applies to any type of data which is common to *all* students, and generally fall into a few common types of data: nominal (e.g., multiple choice, menu selections), counts or totals (e.g., number of times a card is visited or button is clicked, total elapsed time spent on a lesson), and averages (e.g., average time spent reading expository material across a number of such events).

However, there is one type of data researchers frequently wish to collect, but which present some serious problems for analysis. For example, say the researcher wants to see how many times students visit a specific type of help screen. Certainly, the number of times students would choose to access the help would be contingent upon how many opportunities they had to access help. If some students had the opportunity to access help only once or twice, how is their help-selection data to be compared with someone who had many more such help opportunities? Such contingent data present continual analysis problems for researchers (Misanchuk & Schwier, 1992). Some statisticians indicate that such proportions are seldom normally distributed and recommend a number of possible transformations to better represent such data (Cohen & Cohen, 1975, p. 254-259). Even so, the interpretability of such data is limited.

More generally, in any hypermedia environment, there are likely to be a great many data points which are in some way conditioned on the student's experiences previously encountered in the lesson. It is imperative the researcher not jump too quickly to aggregate such data without first carefully examining the range of experiences the student traversed earlier in the lesson. The old saw "garbage in - garbage out" definitely applies here.

Data organization and format. Audit trail data generated by routines such as the one presented in this paper do not readily conform to the usual data input requirements of statistical programs. Indeed, only the most powerful of such programs (e.g., SPSS) are able to take as input almost any kind of form of data. Even so, such data may still need to be "cleaned up" prior to analysis. Such mundane features as commas and quotation marks need to be in the proper format for input into the statistical program. For example, the sample audit trail presented earlier in this paper would need to be somewhat modified prior to statistical analysis using SPSS. The string variables and the embedded quotation marks would need to be brought into conformity with the requirements of the program's data input routines.

It is very likely that the statistical analyst will need to employ other routines, as well, (such as SPSS's INPUT PROGRAM, END INPUT PROGRAM routines) to rearrange the input data to a more acceptable format.

Some analysis techniques and problems. Of course, the particular statistical routines employed will be a function of the research questions asked by the investigator. However, given the wealth of data collected, a number of statistical techniques (in addition to the usual MANOVAs and repeated-measures analyses) become available and attractive due to the existence for each student of a rich data "stream":

- ...multi-way contingency table analysis: related to the problem of contingent data mentioned earlier, the investigator might wish to create for each learner a contingency table of, say, choices given opportunities; these tables can themselves are able to be analyzed across the entire sample.
- ...the continuous supply of data from the student over time might offer researchers chances to look for trend patterns over time. Techniques such as time series and non-linear regression might be useful statistical techniques for such analyses.
- ...occasionally, researchers are interested in classifying students by "type" or "style." The idea is to see if students tend to cluster into meaningful groups based upon their online tendencies collected in the audit trail. While fairly unused in educational circles, a number of statistical profiling and clustering routines exist to help this sorting task (e.g., Hartigan, 1975).

Typical problems encountered during such analysis include, for example, choosing the proper unit of analysis (learner? Or where more than one student sits at a single keyboard, should the computer be the correct unit of analysis?), and determining whether a within-subjects design is appropriate and desired, and if so, choosing the proper design and error terms in the model.

Measurement Error

As with any data collection system, errors can occur in the measures which limit the reliability and interpretability of the information gathered. Although in a computer-based data collection system the measurement errors are not of the type we usually think of when humans collect and record data (data entry mistakes, lack of double checking, etc.), there are still a number of quality control issues which must addressed in order to have confidence in the data. Some of these potential problems are of concern in all measurement settings; others should be considered mainly when preserving non-aggregated data for qualitative analysis purposes; still others are of primary concern when statistical analysis is to be applied to aggregated audit trail data. (In fact, it is curious to note that what could be labeled a source of measurement error when analyzing aggregated data can often be pinpointed when looking at the same data in its original non-aggregated form, that is, by examining each student's audit trail individually.)

General measurement concerns:

- *General disruptions.* Sometimes students kick out a power plug in the middle of a lesson, or a student receives a bad disk which crashes abruptly, or fire alarms sound. The investigator must decide how much incomplete data can be tolerated, and whether the disruption tainted the data collection so as to be invalid or otherwise unusable.

- *Accidents and carelessness.* Students occasionally press the key they did not want. Sometimes they realize their mistake; sometimes they don't. How the computer can provide a means for the student to check and/or modify their answer without being overly intrusive to the overall flow the lesson is a common challenge to researchers.

- *Offline behaviors*: Here the investigator is interested in what the student is doing with the computer besides pressing keys. For example, are students talking with each other or looking on each other's screens? Are students referring to job-aids, workbooks, or other offline materials? How interested do the students look? What is the nature of the interactions between students when working cooperatively? Most often, such offline behaviors are most validly assessed with unobtrusive video or audiotape, but can be assessed with live observers, as well. These types of data can be examined with traditional statistical techniques (e.g., Webb, 1984) or might be treated qualitatively.

Measurement concerns when analyzing aggregated data

- *Awkward means of responding.* If the student is unclear what to do to indicate their response or if it is awkward for them to do so, students might end up making many unintended mistakes or even giving up. Multiple or non-standard keystrokes required to make a simple choice, poorly labeled screen "buttons" or bad screen design distract students from the matter at hand to focus instead on just making the computer work correctly. Although awkward response mechanisms presents a source of measurement error when data are to be analyzed in aggregate, identifying such responses in *specific*, that is, non-aggregated audit trails might be of prime interest during a formative evaluation.

- *Student disinterest.* Otherwise known as, "I just want to get through this damn computer lesson as fast as possible..." Students might want to just hit any key to get through the lesson because they just don't care what happens. The investigator who unquestioningly trusts all data from the computer risks drawing unwarranted inferences about the data (Damarin & Damarin, 1983). Again, such a source of measurement error can often be readily identified when the data are examined on an individual, non-aggregated basis.

- *Question intrusiveness.* This is a thorny issue common to many educational studies. The investigator should be aware that the very act of collecting data might alter the phenomenon being studied. Occasionally, researchers will insert into a computer lesson so many non-critical questions (options, opinions, confirmations, confidences, etc.) that the lesson gets exhausting to go through. The students are in danger of feeling like, "Let's just get ON with it!" This intrusiveness is particularly evident in later stages of the lesson, as the student gets more and more irritated with having to answer seemingly irrelevant questions. Identification of this phenomenon, too, might best occur when examining individual audit trails, perhaps through the "playback" technique presented earlier.

Measurement concerns when analyzing individual, non-aggregated data

- *Individual differences in learners.* Say the investigator wants to look at time spent on the lesson and collects such data online. Such factors as the learner's typical reading speed or physical coordination level (i.e., their motor skills for handling the input devices) have the potential to provide false information about the time-on-task the typical student might take. Additionally, some students have more familiarity with computers (keyboards, cursors, control keys, etc.) than others. When analyzing aggregate data, these effects can be considered random, but when looking qualitatively at individual, non-aggregated data the investigator should be aware of the possibility that these individual differences might confound or dilute interpretation of the data. That is, it may be difficult to draw any valid conclusions about the performance of a lesson from only looking at a few students.

Summary

A method for collecting "audit trails" of data generated by students as they proceed through computer-based instruction was presented and discussed. Specific HyperCard routines were delineated which completely capture the student's online experience, and are able to "playback" the responses to the investigator.

Additionally, data analysis issues surrounding the use of audit trails were presented. The purposes of aggregating or not aggregating such data were compared, some statistical concerns were offered, and measurement issues potentially affecting the interpretability of the collected data were reviewed.

In general, it is expected that techniques and issues presented in this paper will go a long way to improving our understanding of how students experience computer-based instruction, and how we might improve our instructional designs to reflect these human factors.

Appendix: Scripts

All of the handlers that follow are to be installed in the stack script of the stack to be audited. Comments are included in each to make them self-documenting.

```
on openStack
  StartTrail
end openStack
```

```
on StartTrail
  ........................................................................
  -- This handler sets up a global variable called Trail.
  -- It begins with a header with bullets to indicate the
  -- start of a new play of the stack, followed by a line
  -- showing the starting time and date.
  -- The third line is left blank, but stacks can be scripted
  -- to put the user's name, experimental condition, or other
  -- data here.
  ........................................................................
  global startTime,trail,event,lastEventTime
  put "••••••" & return into trail
  put "Stack opened at" && the long time after trail
  put " on" && the long date & return after trail
  set numberFormat to "0.00"
  put the ticks/60 into startTime
  put 0 into event
  put startTime into lastEventTime
end StartTrail
```

```
on closeStack
  SaveTrailFile
end closeStack
```

```
on SaveTrailFile
  -- This writes the Trail global variable to disk

  ........................................................................
  -- End the trail global with closing time and elapsed time
  ........................................................................
  global startTime,trail
  put the ticks/60 into endTime
  set numberFormat to "0.00"
  put return & "Stack closed at" && the long time & return after trail
  put "Total elapsed time =" && endTime - startTime && "seconds" & return after trail
  put "ΩΩΩΩΩΩ" & return after trail

  ........................................................................
  -- The next line specifies the volume and name of the trail file.
  -- By default, "TrailFile" will be created in the same folder
  -- as HyperCard itself.  If you wanted to put it somewhere else
  -- you would put the full pathname into the variable TrailFile.
  -- For example, put "CirrusSys:Data:TrailFile" into TrailFile
  -- would define TrailFile as a file called 'TrailFile'
  -- in a folder called 'Data' on a drive named 'CirrusSys'
  ........................................................................
  put "TrailFile" into TrailFile

  ........................................................................
  -- Next, read to the end of the trail file, if it exists, so
  -- that this latest trail will be appended to it.  If there is
  -- no trail file, this line creates one.
  ........................................................................
  open file TrailFile
  repeat
    read from file TrailFile for 16384
    if it is empty then exit repeat
  end repeat
  write trail to file TrailFile
  close file TrailFile
end SaveTrailFile
```

```
on AddToTrail input
  ------------------------------------------------------------
  -- This handler stores data about mouseclicks in a line in a
  -- global called Trail along with the time at which they occurred
  -- and the target of the mouseclick.
  -- Item 1 = the event number, starting with 1
  -- Item 2 = the total elapsed time in seconds since the stack opened
  -- Item 3 = the target of the mouseclick (a field, button or card)
  -- Item 4 = the name of the card
  -- Item 5 = the elapsed time since the last mouseclick
  -- Item 6 & 7 = the coordinates of the mouseclick
  -- Item 8 & 9 = the coordinates where the mouse button was released
  -- Item 10 = Non-click events such as pulling down menus or
  --          user input to a field.  This is a parameter passed
  --          when necessary.  See the domenu handler, for example.
  ------------------------------------------------------------
  global startTime,trail,event,lastEventTime,DontAddToTrail
  put the ticks/60 into nowTime
  if DontAddToTrail = true then exit AddToTrail
  add 1 to event
  put event + 3 into trailLine
  put trunc(event) into item 1 of line trailLine of trail
  set numberFormat to "0.00"
  put nowTime - startTime into item 2 of line trailLine of trail
  put the short name of this card into item 3 of line trailLine of trail
  put the name of the target into item 4 of line trailLine of trail
  put nowTime - lastEventTime into item 5 of line trailLine of trail
  put the clickloc into item 6 to 7 of line trailLine of trail
  put the mouseloc into item 8 to 9 of line trailLine of trail
  put input into item 10 of line trailLine of trail
  put nowTime into lastEventTime
end AddToTrail
```

```
on domenu x
  AddToTrail "Menu item:" && x
  pass domenu
end domenu
```

```
on ShowTrail
  ------------------------------------------------------------
  -- This handler creates a representation of the usage patterns
  -- of a stack.  It parses a trail file containing data from
  -- one or more runs of a stack and marks the location of
  -- every mouseclick on each card.
  -- To execute this handler, call up the message box,
  -- type "ShowTrail", and press the return key.
  -- This should be done on a COPY of the stack.
  -- The first section creates a new button named Breadcrumb
  -- in the form of a small shadowed circle.
  ------------------------------------------------------------
  global DontAddToTrail
  put true into DontAddToTrail
  domenu new button
  get the id of cd btn "New Button"
  put it into x
  set the showName of cd btn id x to false
  set the name of cd btn id x to "Breadcrumb"
  set the rect of cd btn id x to 100,100,112,112
  select cd btn id x
  domenu "Cut Button"

  ------------------------------------------------------------
  -- Next we locate the file that captured the trail
  ------------------------------------------------------------
  answer file "Where is the trail file?"
  if it is not empty then
    put it into TrailFile
  else
    choose browse tool
    put false into DontAddToTrail
    exit ShowTrail
  end if
  open file TrailFile
  put "*" into TheLine
  set lockmessages to true
```

```
 ------------------------------------------------------------
 -- Next, we go thru each line of the TrailFile, looking
 -- for lines representing mouseclicks
 ------------------------------------------------------------
 repeat until theLine is empty
   read from file TrailFile until return
  put it into theLine

  ------------------------------------------------------------
  -- If it's one of the lines with date, "•", etc., skip it.
  ------------------------------------------------------------
  if the number of items in theLine < 9 then next repeat


  ------------------------------------------------------------
  -- Go to the card where the event occurred
  ------------------------------------------------------------
  put item 3 of theLine into theCard
  if word 2 of theCard = "id" then
   do "go" && theCard
  else
   do "go card" && quote & theCard & quote
  end if

  ------------------------------------------------------------
  -- Find the location of the mouseclick, ignoring pull down
  -- menus and inputs into a field, and paste the Breadcrumb
  ------------------------------------------------------------
  put item 6 to 7 of theLine into theLocation
  put item 10 of theLine into nonClick
  if nonClick contains "Menu item:" or nonClick contains "Input:" then
    next repeat
  else
   domenu "Paste Button"
   put the number of cd btns into x
   set the loc of cd btn x to theLocation
  end if

 end repeat

 ------------------------
 -- Now tidy things up
 ------------------------
 close file TrailFile
 choose browse tool
 put false into DontAddToTrail
 play harpsichord
end showTrail
```

Title:

Constructivism and Instructional Design: Some Personal Reflections

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Constructivism and Instructional Design: Some Personal Reflections

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The field of instructional design (ID) is in a state of rapid change. Recent expressions of constructivist theorists (Bednar, Cunningham, Duffy, & Perry, 1991) have engendered a lively debate, reflected in the May and September 1991 issues of *Educational Technology* magazine and the winter 1992 issue of *ETR&D*. If our IT department is any indication, graduate students across the nation are engaging their professors in heated discussions concerning the fundamental models in our field, and how they hold up to the constructivist onslaught.

This is good. I feel better about the future of ID than I have since I was a graduate student myself. For years, Dave Merrill has pled that more serious attention be given to ID theory development. He finally seems to be getting his wish, but perhaps not the result he anticipated. For a long time, thoughts about the nature of ID theory and its practice have been fermenting in my mind; this paper is my forum for airing some of those thoughts and sharing them with a wider audience. The tone is personal because it deals with underlying assumptions I have made in doing ID. In a way, the paper is a sort of confessional—my tone and stance are much less temperate than any of my previous writing. Narrative forms of research are recently gaining esteem among educators and social scientists (Polkinghorne, 1988; Connelly & Clandinin, 1990; Witherell & Noddings, 1991); I ask you to consider this paper a sort of narrative documentation of my professional beliefs about ID.

The Problem: ID Is Out of Sync

The problem can be simply stated: ID, in its present form, is out of sync with the times.

- Its orientation is behavioristic.
- Its methods are behavioristic.
- Its research base is behavioristic.

I know that these claims make some people mad, particularly people who believe we have completed the "cognitive revolution." They are generalizations, and admittedly there are exceptions. Perhaps a better descriptor would be 'positivistic' rather than 'behavioristic.' But the image of ID to outsiders is definitely behavioristic. Survey any group of faculty within a college of ed; you will find a stereotyped impression of ID as no-nonsense, results-driven behaviorism applied to education. A similar image holds among educational researchers: members of the IT SIG group within AERA tend to be seen as positivists *par excellence*.

To most of us, this comes as no surprise. To some, our positivistic/ behavioristic bias is not a problem. In the current zeitgeist of increasing constructivism, however, behavioristic notions of ID find themselves increasingly out of the mainstream of educational thought. I wonder, prior to the *Ed Tech* issues, how many ID grad students had really confronted the disparity between progressive educational thought and the ID models learned in classes. To many, the *Ed Tech* issues must have contributed to a loss of innocence. The line is now clearly drawn, and I suspect many find themselves uncomfortable as they see unwanted conceptual baggage accompanying the tools and models of their field.

It is possible, though, that I am merely projecting my own past perceptions and experiences onto others. As a graduate student, I felt privileged to have worked closely with David Merrill and Charles Reigeluth at Brigham Young University, particularly in the development of elaboration theory (Reigeluth, Merrill, Wilson, & Spiller, 1980). I bought into the field—its theories, models, and aims—yet I always felt an ambivalence toward what I perceived as cut-and-dried design prescriptions in areas that I felt so personally "mushy" about. My respect for the complexity and difficulty of design decisions always made me hesitant about explicit, canned procedures and models that were meant to answer all the questions. I felt that ID lacked a sense of perspective or a sense of modesty toward the awesome task of meeting people's learning needs. Recently I came across some old notes I had made, dated 15 March 1978, titled "Issues that still haven't been resolved in SSDP (Structural Strategy Diagnostic Profile—the old name for elaboration theory). Excerpts of those notes are reproduced in Table 1. Re-reading those notes reminded me that many of the issues are still pertinent to today's discussion, including the nature of knowledge and content, the role of context, parts versus wholes, and accommodation of alternative structures. The task of adapting ID theories to address these issues still remains.

In the ID articles I have written since then, I have tried to steer a delicate balance between being too accepting of the "received view" about ID and being too radical. I did not want to lose my audience. My moderate tone belied the urge within to shout, "Wait—don't you see? We've got it wrong!" That urge was heightened by the recent comments of an anonymous IT/SIG reviewer on a paper critiquing elaboration theory (Wilson & Cole, 1992):

> You have put your finger on a fundamental difference in approaches taken by those who believe that instruction can be designed to teach knowledge and those who believe that knowledge is constructed by learners....I would go so far to say that the two positions are irreconcilable. If you accept what the "humanistic theorists" say, then you cannot simply revise [elaboration theory] in the ways you propose to make it fit in with these views. You have to throw it out entirely!

I'm not as pessimistic about the possibility of reconciliation. *In fact, that is a major theme of this paper, that there can be a constructivist theory of instructional design.* But I am coming to believe that the best way to handle differences is not to be coy, not to downplay problems, but to be unflinchingly honest and straightforward in criticism, and aggressive in offering alternative design concepts. My experience has now started me wondering how many other professionals who, rather than confront their problems with the models, have simply walked away from the problem by disengaging themselves from the models or from the field.

On the Objectivist/Constructivist Debate

A few things have bothered me about the objectivist/constructivist dialogue. Rather than comprehensively examine the issue, I want to raise a few points.

1. ***You don't have to be a philosopher to take a position.*** Among the *Ed Tech* contributors, Perkins and Cunningham have considerable training in philosophy, but to my knowledge the remaining writers are, like you and me, relative novices in that domain. Our interest in these issues derives from a desire to do the right thing, to be knowledgeable about sources of bias and damaging assumptions we can make in our work. I hope that practitioners and researchers do not defer to the "experts" on issues so central to defining the field. At the same time, I am busy trying to expand my breadth and knowledge base about philosophy. As I read more Schön, more Bruner, and more postmodern philosophy, my perspective toward ID is necessarily influenced. That change in perception is for the good; I like the feeling that I am growing in understanding the meaning of my field. (And I confess I tend to grow impatient with fellow researchers who show no inclination to broaden their understanding of the issues squarely facing the field.)

How do our ideas of structure relate to learning/ memory theorists' ideas about how memory is organized? Mayer, Greeno, Ausubel, Kintsch, Craik & Tulving, Norman & Lindsey, Quillian & Collins, McConkie, etc....

The problem of "segmentation": Are we sure the contents of a discipline can be broken down into individual concepts, principles, etc.? What about what theorists call "verbal information," "meaningful verbal materials"—facts that are important to know but don't connect to any principles directly....Are we rather talking about a mere skeleton in our work, which, to be complete, needs to be fleshed out by facts, details, context, etc.?....

It seems to me that there are certain kinds of content whose purposes do not admit to use of synthesizers/epitomes on an elaborative approach. Narratives, for example, often have a dramatic component, as if the teacher/author were telling a story. It would be senseless to let the cat out of the bag prematurely simply to "stabilize" the content for the learner. An effective alternative (in certain situations) is having the student on the edge of his seat waiting in suspense for what happens next....

Bruner (1966) distinguishes between passive and active learning, between what we know and what we do with what we know. How do these seemingly separable kinds of knowledge relate to our scheme? Is true active learning on the rule-finding or rule-using level? Are procedures and principles real problem-solving behaviors? Would Ausubel object that we devalue facts and verbal information unnecessarily?....

Is 'content' defined as "What is," "What is presented to the student," or "What is expected to be learned?"

Table 1. Excerpts from my notes on elaboration theory, circa 1978.

2. ***Nobody I know admits to being an objectivist.*** Molenda (1991) points out that objectivism is primarily a pejorative label given by constructivists to the offending others (Johnson, 1984; Lakoff, 1987; Bruner, 1986). That fact alone is enough cause to worry. It's hard to talk seriously about a philosophical position that no one admits to. This goes for caricatures made by both ideological sides of the *Ed Tech* dialogues. Very few people hold radical positions of either persuasion.

Please note that my complaint has to do with labels and descriptions; many people may not call themselves objectivists, but their way of seeing may be very different from a constructivist perspective. Philosophers holding this more traditional view of the world call themselves *realists* (House, 1991; H. Putnum, 1990). To my understanding, realists do believe there is a "reality" out there, and that the quality of mental representations can be judged by their correspondence to that reality. This "correspondence theory of truth" is one of many issues hotly debated by philosophers. If they can disagree about it, I imagine the rest of us can as well.

The cross-talking going back and forth about constructivism reminds me of an anecdote I recently read in *Readers Digest* (Safire, 1991) about a Florida politician, asked to take a position on a county option to permit the sale of liquor:

> "If by *whiskey*, you mean the water of life that cheers men's souls, that smooths out the tensions of the day, that gives gentle perspective to one's view of life, then put my name on the list of the fervent wets.
>
> "But if by *whiskey*, you mean the devil's bew that rends families, destroys careers and ruin's one's ability to work, then count me in the ranks of the dries." (p. 14)

If by constructivism you mean the solipsism and subjectivism portrayed by Merrill or Molenda, then I am a strident opponent. But if by constructivism you refer to the reasoned, persuasive philosophy of a Cunningham or a Perkins, then count me in as a constructivist.

3. ***Neither side is right.*** I am suspicious of simple dichotomies like the idea that reality is either inside or outside of the mind. The analogy implicit in such claims is that the mind is like a box (Heideggar, 1984; Faulconer & Williams, 1990). Inside the box are reflections of what lies outside. Martin Heideggar's ontology rejects the box metaphor of mind, and the inner/outer dualism that goes with it (see Faulconer & Williams, 1990; Dreyfus, 1991; Winograd & Flores, 1986).

> Rather than accepting the metaphor of the box, with the human subject walled off from the nonhuman, objective world, Heideggar's analysis leads to the conclusion that human being is already being-in-the-world. There is no inside walled off from the outside. (Faulconer & Williams, p. 46)

According to Heideggar and other phenomenological philosophers, the starting point is recognizing that we simply are in the world, working, acting, doing things. Turning Descartes' famous maxim on its head, the motto becomes "*I am* [in the world]; *therefore I think*."

On this view, individual cognition is dethroned as the center of the universe and placed back into the context of being part of the world. This philosophy is reminiscent of the socially oriented, connected ways of knowing found among women by Belencky and colleagues (Belencky, Clincy, Goldberger, & Tarule, 1986). I am attracted to such holistic conceptions of the world, even if my understanding of the philosophy is still incomplete (see Polkinghorne, 1990 for a good, short introduction to many of the issues). My reading is enough to make me suspect that much of the objective/constructive debate is based on the wrong questions.

4. ***Constructivism is a philosophy not a strategy.*** I reject the idea that a particular instructional strategy is inherently constructivistic or objectivistic. Constructivism is not an instructional strategy to be deployed under appropriate conditions. Rather, constructivism is an underlying philosophy or way of seeing the world. This way of seeing the world includes notions about:

- the nature of *reality* (mental representations have "real" ontological status just as the "world out there" does)
- the nature of *knowledge* (it's individually constructed; it is inside people's minds, not "out there")
- the nature of *human interaction* (we rely on shared or "negotiated" meanings, better thought of as cooperative than authoritative or manipulative in nature)
- the nature of *science* (it is a meaning-making activity with the biases and filters accompanying any human activity)

When we see the world in constructivist terms, we go about our jobs in a different way, but the difference cannot be reduced to a discrete set of rules or techniques. Let me give an example.

My son Joel recently turned eight, and for his birthday we presented him with a computer math drill-game. He is a good math problem-solver—he likes to play with numbers and invent routines —but because of a schooling mixup, he is behind in mastering his math facts. I essentially said, "Joel, this is a fun game you will enjoy; it will also help you learn the addition and subtraction skills that you're a little behind in. It's no big deal. You will be glad, because learning that stuff is something you want too."

Does my gift of a drill-and-practice program make me an objectivist? I deny that it does. I also deny that I am violating my deeply held constructivist principles about people and the way we learn. People do construct meaning from their experiences; learning should be meaningful and derive from an authentic context; people should be allowed to pursue individual learning goals. I believe that Joel has a pretty good idea of what the game is doing for him, and the kind of fun he is deriving from it. As he chooses to make use of the game, he *is* actively constructing meaning and new knowledge. Joel has plenty of other opportunities to exercise his more creative talents; his use of the game is filling a needed learning gap to meet the expectations and pace set by his school. He was much happier in school two weeks later, when he aced the timed math test and came home to tell us about it.

My point is that a given instructional strategy takes on meaning as it is used, in a particular context. If I had tricked my son, "Joel, look at this computer game. It's better than Nintendo!" and pretended that he was already great at his math facts, and that the game had no bearing on his schooling, then I would have felt in violation of my philosophy. So the same instructional technique could have vastly different meaning (and effects) depending on its context of use.

Another example—a journal entry from Scott, a teacher in my *Reflective Educator* class last semester:

> Third hour composition I went to a seating chart, the first time I've done that here. I caught them as they came in and told them where to sit. Great improvement. Everyone working hard on their papers....I sense the students are relieved that I've imposed more structure.

Scott teaches at an alternative high school. His philosophy, as expressed in journal entries, class contributions, and teaching methods, is definitely constructivistic and anti-authoritarian. Yet imposing a seating chart on a class is a clear act of asserting authoritative control and imposing structure. Is Scott betraying his principles, or can an ostensibly "constructivist" instructional technique actually serve his constructivist learning and teaching goals? The students' answer to that is clear: they welcome the new arrangement and view it as supporting their own learning goals.

Too often, constructivism is equated with low structure and permissiveness—imposing predefined learning goals or a learning method is somehow interfering with students' construction of meaning. In extreme cases, that may be true. Yet to help students become creative, some kind of discipline and structure must be provided. Laurel (1991) cites Rollo May (1975), who makes this point very well:

> Creativity arises out of the tension between spontaneity and limitations, the latter (like river banks) forcing the spontaneity into the various forms which are essential to the work of art....The significance of limits in art is seen most clearly when we consider the question of form. Form provides the essential boundaries and structure for the creative act. (quoted in Laurel, 1991, p. 101)

In other words, an instructional strategy that imposes structure may actually help learners make constructions needed for learning. Joel's computer game or Scott's seating chart may be hindering or serving constructivist learning goals: You can't tell by looking only at the strategy; you have to look at the entire situation and make a judgment. That is the role of the teacher or instructional designer: to make professional judgments about such things.

Implications for Design Theories[1]

In this section, I turn to the more difficult issue of defining ID theories and their relation to practice.

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[1] Some may object to the use of the term 'theory' when applied to instructional design, arguing these alleged theories are really nothing more than technological models. I retain Reigeluth's (1983a) use of 'theory' for two reasons: (1) to distinguish between ID theories and instructional development models that prescribe a methodology for managing ID projects (cf. Andrews & Goodson, 1980), and (2) because philosophers of science liberally apply the terms 'theory' and 'model' to a variety of frameworks of varying complexity, formality, and power (Suppe, 1977).

What is Instructional-Design Theory?

Traditionally, ID theories are seen as *prescriptive* in the the sense that

- they provide recipes or heuristics for doing designs, and
- they also specify how end-product instruction should look.

Thus in both a product and process sense, ID theories serve as guides to professional practice. Conceptually, ID theories are much closer to engineering than to science. They are about how to get something done, how to design a solution, not about how the world is. In that sense, they are really less theories and more models for action, for problem solving.

Such design theories may be based on a lot of hot air, or they may have some validity. What kind of knowledge base are these theories built on? Several forms of knowledge may contribute to an ID model, including:

- ***scientific*** knowledge of learning and related sciences
- ***craft*** knowledge of effective design, based more on teaching practices than on formal scientific research
- ***idiosyncratic*** knowledge about instruction unique to the ID profession, untested by formal research yet functionally important to ID practice.

Reigeluth (1983a) has outlined a prescriptive framework for embodying this knowledge. A series of rules are developed connecting existing conditions, desired outcomes, and recommended methods to instrumentally obtain those outcomes. For example, if your learners are new to a concept and you want them to learn it at an application level, then you might present a statement of the definition followed by examples and practice opportunities to classify new cases. An ID theory builds a collection of similar IF-THEN rules; designers are then supposed to apply those rules to their various situations.

This is a fairly technical view of design activity. Schön (1987), in fact, refers to exactly this type of thinking as *technical rationality*.

> From the perspective of technical rationality...a competent practitioner is always concerned with instrumental problems. She searches for the means best suited to the achievement of fixed, unambiguous ends...and her effectiveness is measured by her success in finding...the actions that produce the intended effects consistent with her objectives. In this view, professional competence consists in the application of theories and techniques derived from systematic, preferably scientific research to the solution of the instrumental problems of practice. (p. 33)

Schön's technical rationality looks a lot like Reigeluth's conditions–outcomes–methods framework. Schön does not deny that some problems encountered are routine ones that relate to the rules and concepts of the discipline. However, professionals go far beyond technical rationality when they encounter novel problems:

> There are also unfamiliar situations where the problem is not initially clear and there is no obvious fit between the characteristics of the situation and the available body of theories and techniques. It is common, in these types of situations, to speak of "thinking like a doctor"—or lawyer or manager [or instructional designer!]....
>
> We would recognize as a limiting case the situations in which it is possible to make a routine application of existing rules and procedures....Beyond these situations, familiar rules, theories, and techniques are put to work in concrete instances through the intermediary of an art that consists in a limited form of reflection-in-action. And beyond these, we would recognize cases of problematic diagnosis in which practitioners not only follow rules of inquiry but also sometimes respond to surprising findings by inventing new rules, on the spot. (Schön, 1987, p. 35)

Technical rationality suggests a clear demarcation between theory and practice, with categories of basic knowledge, applied knowledge, and practice. Theory is what gets written in textbooks and professional journals, while practice tends to be mistrusted since practitioners never have the good sense to apply theory correctly. On the other hand, Schön's reflective practitioner model blurs the line between theory and research, suggesting that practitioners embody personal theories of practice, and often assume a kind of research stance toward their work (see also Winn, 1990). Schön makes clear the philosophical basis of his view of practice:

> Underlying this view of the practitioner's reflect-in-action is a *constructionist* view of the reality with which the practitioner deals—a view that leads us to see the practitioner as constructing situations of his practice, not only in the exercise of professional artistry but also in all other modes of professional competence....[O]ur perceptions, appreciations, and beliefs are rooted in worlds of our own making that we come to *accept* as reality. (Schön, 1987, p. 36)

In contrast,

> technical rationality rests on an *objectivist* view of the relation of the knowing practitioner to the reality he knows. On this view, facts are what they are, and the truth of beliefs is strictly testable by reference to them. All meaningful disagreements are resolvable, at least in principle, by reference to the facts. And professional knowledge rests on a foundation of facts. (p. 36)

Thus Schön is setting certain conditions for a constructivist model of instructional design. If you buy into a constructivist idea of the world, learners become active creators of meaning (and teachers to others), and teachers are continual learners.

> Communities of practitioners are continually engaged in what Nelson Goodman (1978) calls "worldmaking." Through countless acts of attention and inattention, naming, sensemaking, boundary setting, and control, they make and maintain the worlds matched to their professional knowledge and know-how....When practitioners respond to the indeterminate zones of practice by holding a reflective conversation with the materials of their situations, they remake a part of their practice world and thereby reveal the usually tacit processes of worldmaking that underlie all of their practice. (Schön, 1987, p. 36)

I have cited Schön heavily because I am convinced that we need to rethink the roles of formal ID theory and the ID practitioner (see also Hoshmand & Polkinghorne, 1992). Schön's model is not complete—for example, he does not pursue the ethical/moral dimensions of professional decisionmaking in an institutional context. But his views serve as a valuable starting point for discussion.

The expert/novice literature within cognitive psychology reaches similar conclusions about the nature of expertise. Researchers have found that expertise is

- largely intuitive and inaccessible to direct reflection (e.g., Bloom, 1986)
- more pattern-matching than rule-following (Suchman, 1987, Bereiter, 1991)
- more qualitative than quantitative (White & Frederiksen, 1986)
- highly context- and domain-dependent (Brandt, 1991).

Such a view of expertise seems also to fit the field of ID. We know that professional designers are highly flexible and adaptive in applying their knowledge to working problems (Nelson & Orey, 1991; Thiagarajan, 1976; Nelson, Magliaro, & Sherman, 1988); moreover, their use of knowledge seems to differ significantly from formal theories (Tessmer & Wedman, 1992; Wedman & Tessmer, 1990). With this view of expertise, the precise role of traditional theory is left in question. If ID theories are not descriptive science, and not a set of rules to be unambiguously applied to problems, then what are they and what value do they have?

One possibility is that the recipes contained in ID theories may have some value to novice designers. R. Putnum (1991) found that when learning a complex subject, novices tend to grasp onto formulas and recipes to support initial performance, then chang their use of the recipes as they gained expertise. The main problem with this rationale, though, is that ID theories are not formulated as simple recipes; they are *not* easy-to-use "hooks" into a subject. Rather, ID theories are typically represented as formal, technical-sounding systems with extensive jargon, big words, and acronyms. The ID theory papers I have read are anything but a support to novices. ID theories are written as though they were serious science; novices require another type of representation altogether to support their initial learning needs.

Another possibility is that ID theories are not really meant to be used by human designers in normal situations, but rather are best suited to computer-based training and automated instructional design. This possibility is much more promising, even though both Gagné and Merrill have denied the need for separate formulations of ID theory for computers and traditional media (Gagné, 1988; Merrill, 1988) . Of course, there is still the question of whether theorists can successfully represent design knowledge with computers. It may turn out that the IF-THEN rule approach to design may be unable to capture true design expertise. This is, however, an empirical question worthy of continued investigation.

In summary, ID theory, with its prescriptive orientation toward both procedure and product, lies in conceptual limbo. Its status remains unclear in light of cognitive/constructivist views on expertise and professional problem-solving. In spite of these difficulties, I believe that there can be such a thing as a constructivist theory of instruction. At the paper's conclusion, I recommend several changes to revitalize ID theory and its place within practice and within the discipline.

The Cooperative Metaphor

Ken Komaski, director of the EPIE Institute, raised an issue a few years ago that has continued to affect my views. Citing Buchanan's (1963) study of ancient Greek and medieval thought, Komaski suggested that technologies can be divided into two distinct groups:

> In the first group are the arts practiced on matter and on the many things and forces found in nature. These arts, such as sculpture, agriculture, hydrology, painting, carpentry, cooking, etc., are arts in which "the form in the artist's mind...could be impressed on the matter...which could be fashioned and formed [Buchanan, 1963]." [O]ur uses of all technologies have been—and continue to be—influenced by this view of "technology as a system of exploitation." (Komaski, 1987, p. 9; italics removed)

The exploitative technologies are contrasted by:

> those arts "practiced on human beings, who also have artistic capacities." In humans there are "natural processes which if left to themselves might accomplish their ends, but if aided by the professional would accomplish their ends more easily and more fully. Medicine and teaching were the frequently discussed examples of such arts. They were called cooperative arts because they were understood to be cooperating with rational natures." The physician who gains the cooperation and confidence of patients, and the teacher who gains the willing cooperation of students, are much more apt to end up with healthy patients and competent learners than those doctors and educators who fail to gain such cooperation. (Komaski, 1987, p. 9)

Komaski notes that "it is the *exploitative technologies*, with their undeniable and demonstrable efficiency and effectiveness, that have shaped our thinking about, and our practices of, all technologies—including those such as medicine and teaching that, presumably, function more effectively when practiced as *cooperative technologies*" (Komaski, 1987, pp. 9–10; see also Mumford's [1967] distinction between authoritarian and democratic technologies).

It would be an interesting exercise to classify various known educational technologies on the exploitative/cooperative continuum. I am afraid that traditional ID theories fall too neatly into the exploitative category, with attendant consequences. The despised factory model of schools has a close cousin in the machine model of ID. The content of current ID theories also belies this orientation. In Reigeluth's green book (Reigeluth, 1983b), only the Gagné chapter and Keller's ARCS chapter treat student attitudes in any lengthy way. ID's manipulative bent is ironic, given the recent emphasis on working with schools in restructuring initiatives (e.g., Banathy, 1991) and on cognitive apprenticeships (e.g., Wilson & Cole, 1991). We clearly need more cooperative metaphors and rhetoric in our ID literature.

Task/Content Analysis and the Nature of Knowledge

Does all learned (or taught) knowledge have to be pre-analyzed? Of course not. There is much learned within any instructional environment that goes far beyond the instructional objectives. Curriculum theorists and media critics have been making that point for years (Hidden curriculum reference; Hlynka & Belland, 1991). Yet ID theorists and practitioners give every indication that their method of slicing up the world is *the* method, and that the content resulting from their analysis is *the* content to be taught to students. More than anything else, this aspect of ID theories has troubled me (see Wilson & Cole, 1992 for a similar discussion).

Eisner (1988) puts the counter argument succinctly in an abstract to a paper:

> Knowledge is rooted in experience and requires a form for its representation. Since all forms of representation constrain what can be represented, they can only partially represent what we know. Forms of representation not only constrain representation, they limit what we seek. As a result, socialization in method is a process that shapes what we can know and influences what we value. At base, it is a political undertaking. (p. 15)

The conceptual schemes we apply to the world constrain that world. Similarly, the schemes instructional designers apply to content constrain and shape that content, necessarily distorting it to fit our preconceived notions. If by some chance the educational community were to agree on knowledge categories, then there might be some basis for using those consensual categories in content and task analyses. But educators do not agree. Alexander, Schallert, and Hare (1991), in a recent review, found 25 distinct knowledge types cited in the educational literature on language and cognition. And that article was an attempt to simplify the problem!

If our knowledge categories are faulty (which they are), then how can we design adequate instruction? A short answer is, don't make the quality of your instruction rise or fall on the quality of your analysis. There is more to instructional design than analysis. Bunderson made essentially the same point years ago in his discussion of the "lexical loop" (Bunderson, Olsen, Gibbons, & Kearsley, 1981). The lexical loop refers to the parade of print-to-print translations we put content through as part of a traditional design process, beginning with needs and content analyses and ending in paper-based tests (see Table 2). As an alternative, Bunderson proposed a series of qualitative "work models" progressing in difficulty and fidelity to the target setting. These work models or learning environments are highly reminiscent of White and Frederiksen's (1986) progression of practice environments based on careful cognitive task analysis of mental models; I believe that such analyses remain highly relevant to the design of instruction, particularly multimedia products.

Knowledge of the Master

The Lexical Loop	Work Models
Translation to goal statements through goal/job analysis.	Master performance is documented through multiple media.
Translation to objectives list through task analysis.	Work models are designed of progressively increasing difficulty. —Learning environments simulate real-life environments. —Students practice holistic as well as parts skills.
Translation to print-based tests through test item technologies.	—Authentic tools are available. —Info can be accessed through job aids, help systems, and other resources. —Coaching, mentoring, and peer consultation is available as needed.
Translation to print-based media using text-design principles.	Students complete work models 1...n.
Student expected to transfer text material into skills ot the master.	Student demonstrates master's knowledge/skill in real-life performance environment.
(Actually, negligible transfer occurs to everyday life.)	

Knowledge of the Master

Table 2. Two paths from mastery to mastery (derived from Bunderson, et al., 1981, p. 206).

The role I am advocating for analysis is fairly modest. Analysis provides an overall framework for instruction, and provides extra help on some tricky parts, such as identifying likely misconceptions or previous knowledge that may undercut students' efforts to understand the content. The role of the designer is then to design a series of experiences—interactions or environments or products—intended to help students learn effectively. Neither the instruction nor the assessment of learning can be as confidently dictated as they were thought to be in the past. But the important point to keep in mind is that the design role is not lost in such a revised system; the design still happens, only it's less analytical, more holistic, more reliant on the cooperation of teachers and materials and learners to generously fill in the gaps left gaping by the limitations of our analytical tools. Instruction thus construed becomes much more integrally connected to the context and the surrounding culture. ID thus becomes more truly *systemic* in the the sense that it is highly sensitive to the conditions of use.

In summary, no matter whose 2X3 scheme you use, the world doesn't always fit such neat epistemological categories. Force-fitting people's expertise into ID taxonomies sometimes can do more harm than good. My recommended alternative is not to throw away the taxonomies entirely, but simply to:

1. admit the tentativeness of any conceptual scheme applied to content
2. realize that no matter how thorough the task-analysis net, it doesn't come close to capturing true expertise;
3. realize that since content representation is so tentative, designed instruction should offer holistic, information-rich experiences, allowing opportunities for mastery of un-analyzed content;
4. always allow for a lack of fit between the conceptual scheme and any given content;
5. realize that the very points of lack of fit can be the most critical to understanding that content area;
6. always be on the lookout for those critical points of idiosyncratic content demands.

Viewed in such a way, content analysis is less a leveling exercise and more an exploration of the terrain, noting and even exploiting rough spots. Rules, verbal information, and other such categories cease to have such literal epistemological status, and become mere tools in the design process. The change is largely one of attitude and stance. I personally do not write behavioral, typed objectives anymore unless required by the sponsoring agency. I try not to teach each content type separately (i.e., verbage apart from skills). Rather, I do what Gagné and Merrill (1990) have advocated: I try and combine all the learning outcomes into problem-solving instruction. There is a variety of possible strategies to address this problem, ranging from conservative to radical. All, however, should be able to fit within a constructivistic ID framework.

The Mystery of Expertise

A constructivist view of knowledge leads to another dilemma central to the ID process:

Subject matter experts know the content best but often have least access to it.

Because expert knowledge gets automatized, conscious representation typically drops out of the picture.

The corollary is just as disturbing:

To go beyond routine mediocre rule-based ID, a designer needs to know content deeply.

Shulman (1987) talks about the many kinds of sophisticated knowledge required of teachers. In addition to knowing the content, they must know how to teach it. This typically does not come automatically, but only after years of teaching the same subject (Berliner, 1986). Designers who script instruction from a newly acquired, superficial content knowledge cannot be expected to find just the right analogy, just the right way of approaching a topic. They do have an advantage over the non-teaching expert in that their understanding of the subject is freshly acquired; that means they have greater access to strategies that worked for them. But this advantage applies only to initial learning levels: Once instruction moves to non-elementary tasks, the designer is on more wobbly ground and lacks the insight needed to create the *best* teaching methods (if such a thing indeed exists). Falling back on known design concepts is not the optimal design solution, but becomes a means of only resort in such situations.

Together, these two problems pose a formidable paradox for ID: The people who know the subject best often can't relate to the learner, while the designer, with a good general schema for teaching and a closer feel for the learner's needs, doesn't have a feel for the subleties of the content and is thus left to deal in superficials.

The role of the knowledge engineer—the designer's counterpart in AI—is a subject of continuing debate (e.g., Winograd & Flores, 1986; Dreyfus & Dreyfus, 1986); thus I am surprised that the designer/SME relationship is not more controversial than it is. We should be asking the same tough questions of designers that we ask AI knowledge engineers: Where does the expertise really come from? What is lost in the translation? Are IF-THEN rules sufficient to characterize expertise, or do we need a neural network? Can expertise be digitally represented? How can we make use of a greater variety of representation forms in our designs?

The standard metaphor for the designer/SME relationship is *extraction*: The designer has good people skills, asks the right questions, pushes the right buttons, and presto!—out comes the expertise, on paper no less. But of course things cannot be so simple. The level of communication between SME and designer needs to move beyond superficialities; somewhere between the two of them there must occur a synthesis of meaning; the design process must be deeply collaborative for good design to occur. I personally don't know how this happens. It remains a mystery.

Instructional Strategies

ID needs a richer language, a deeper conceptual framework for classifying instructional strategies. While this is not the place for such an effort, I have merely sketched out in Table 3 a number of instructional strategies that seem to facilitate more active construction of meaning (see also Wilson & Cole, 1991).

Simulations
Strategy and role-playing games
Toolkits and phenomenaria
Multimedia learning environments
Intentional learning environments
Storytelling structures
Case studies
Socratic dialogues
Coaching and scaffolding
Learning by design
Learn by teaching
Group, cooperative, collaborative learning
Holistic psychotechnologies

Table 3. A sampling of alternative instructional strategies.

A defender of traditional ID could suggest that our present theory base already contains prescriptions for designing all of the above. I would only counter that each of the above strategies deserves its own mini-design model, and that many traditional design concepts seem only to get in the way. It seems ludicrous, for example, to discuss simulation design using terms such as "expository," "inquisitory," "synthesizer," and "summarizer." A new framework and accompanying language is needed.

Student Assessment

Shepard (1991) recently reported some interesting findings about psychometricians' beliefs. About half of those surveyed believe in close alignment of tests and instruction and careful, focused teaching of tested content. Shepard argues, however, that such beliefs correspond to a "behaviorist learning theory, which requires sequential mastery of constituent skills and explicit testing of each learning step"

(p. 2). She argues for a constructivist alternative that emphasizes more authentic methods of assessment such as interviewing, observations, and holistic task performances (see Perrone, 1991; Linn, Baker, & Dunbar, 1991).

Jonassen (1991a) takes what I consider to be a more radical stance towards assessment, extending Scriven's (1973) notion of goal-free program evaluation to the goal-free assessment of student outcomes.

> Constructivistic outcomes may be better judged by goal-free evaluation methodologies. If specific goals are known before the learning process begins, the learning process as well as the evaluation would be biased....Criterion-referenced instruction and evaluation are prototypic objectivist constructs and therefore not [sufficient] for objectivistic environments. (p. 29; change based on Jonassen, 1991b)

I take exception to Jonassen's position for reasons I discuss below, but I am ambivalent about the general issue of assessment. Surely ID theory makes assumptions that make some people feel uncomfortable, for example, that instruction is purposive and goal-directed, and that attainment of those goals can be assessed. I believe these assumptions can be wholly compatible with a constructivist philosophy; here I differ with Jonassen. And certainly, assessment need not go to the extreme of being goal-free. It seems that a key question to ask is, Does the test performance require all of the contextualized reasoning and performing that the target performance would require? (Frederiksen & Collins, 1989). The question is one of fidelity and validity, not of goal-directedness.

I do not have a problem with the idea of goal-directedness and measurement, but I do have a problem with how it is often done. A true mastery model with micro levels of assessment would only be appropriate with highly defined technical content; I believe such methods would rarely be appropriate in public schools, though somewhat more often in training settings. Instructional designers in both school and corporate settings feel the need for better assessment methods that can be more fully integrated into the performance and instructional systems. I have not sorted out all the issues; I raise the question because of its clear importance to the field and to society at large. I continue to believe that improved assessment methods can be developed that are more consistent with a constructivist framework.

Concluding Thoughts

The central issue of this paper is this: Is a constructivist theory of instructional design possible? and if so, What might be it be like? In typical backwards fashion, let me return to the question of the nature of ID theory by defining terms.

Instruction—teacher(s) and student(s) in interaction trying to learn something. Together they form an instructional subsystem within a larger system and community.

Design—"the process by which things are made...designers make representations of things to be built" (Schön, 1990, p. 110). Design is always done within constraints.

Constraints inherent in the design of instruction include:

a. Some situations don't even have teachers *per se*. Thus the teacher may be broadly thought of as the guiding agent, directing the learner toward accomplishing the goals of instruction. Learners themselves often function in the teacher role, as do instructional materials and programs.

b. Designers can usually exert more direct influence on the teacher side than on the learner side of the instructional system. At the same time, designers ignore considerations of the learner at their peril.

c. Designers can usually exert more direct influence over materials and tools than over the interaction between learner and teacher.

d. At the same time, the nature of the precise interaction between learner and teacher is at the heart of understanding instruction.

These constraints pose dilemmas for constructivist designers. As much as we may like to focus on individual learners' cognitions, often our access is extremely indirect and limited. This also helps to explain why ID is often a goal-based, stimulus-design oriented endeavor, working within a noisy system that is near chaos. It is no wonder that we get no respect; my response to critics who think we should get entirely out of such a messy business is, "If we didn't do it, somebody else would. Practitioners of ID need somewhere they can turn to, and our theories are as good as the next guy's." (I am actually serious about this.)

I have become convinced that a field is largely shaped by the central questions it puts for itself. In the case of ID, the questions are tough; there are no good answers, the best we can do is put forth some best guesses. We pay attention to stimulus design (a dirty word among cognitivists) because we have no choice. We prescribe general principles of message and interface design because those are aspects of the instructional system that lie somewhat within our power to influence. For good reasons we tend to get beat up by cognitivists, constructivists, and humanists; yes, it's a dirty job, but somebody's got to do it!

The next generation of ID theory needs to better fit the needs of the practitioner:

- ID theories need to be thoroughly grounded in a broad understanding of learning and instructional processes. That foundation needs to be continually evaluated and revised.
- We need more modest principles that designers can flexibly apply. These principles should be generic and principle-based in order to to be relevant to the wide variety of situations encountered in everyday practice.
- In addition to generic principles, we need specific heuristics for dealing with recurring problems and situations in ID practice. In particular, heuristics should be developed that are sensitive to:
  —*setting* (schools, business, museums, etc.)
  —*media* (computer, instructor-led, workbook, etc.)
  —*product type* (stand-alone product, program, system, etc.)
  —*resources* (time, money, constraints).
- ID theories need to reflect a view of ID as a profession. Designers need sophisticated schemas of design that go beyond the "technically rational" models presently available. Students should be encouraged to develop personal models of action through extensive practice in authentic settings with coaching and opportunities for reflection. (Note the theme of reflection running through students, teachers, and designers.)

Let me conclude by drawing a parallel with a couple of other disciplines, lest we think that we're alone in this chaotic science of design. Artificial intelligence right now is facing some of the same crises we are confronting. So is the field of human/computer interface design. Both of these fields have a strong tie to learning and cognitive psychology. Both rely heavily (at least in theory) on user testing and field validation. Old-time AI theorists presently are being challenged by connectionists, who believe that parallel processing via neural networks is a more promising way to go than symbolic manipulation of IF-THEN rules. The controversy goes beyond symbolic versus networked processing. A growing number of AI researchers have lost faith in traditional views of the representability of knowledge; the "situated" movement within AI goes so far as to deny that knowledge is a structure, and that memory is anything more than process (Clancey, 1991; Brooks, 1991). The field of interface design is going through similar growing pains, moving from a screen-design view of the field to a global, holistic view of the entire human experience with computers (Laurel, 1990, 1991). This revised view of interface design has more to do with human activity than icons, buttons, and windows, more with dramatic metaphors, agents, and virtual worlds. And interface designers are moving away from controlled, linear design models toward rapid prototyping and participatory design (Bødker & Grønbaek, 1991).

I don't doubt that AI will be around in twenty years. Nor do I doubt that people will still be studying how computers and humans work together. The theories and concepts may change, but the basic questions are still there; they cannot be ignored. Likewise, ID will not go away; this is because the questions behind the field are genuine questions. The challenge for ID theorists is to continue to adjust our theories, or to replace them with better ones. The goal is to make our theories worthy of the questions.

Author Notes

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Title:

Evaluating the Impact of Technology at Peakview Elementary School

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EVALUATING THE IMPACT OF TECHNOLOGY AT PEAKVIEW ELEMENTARY SCHOOL

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Clearly, something special is happening at Peakview Elementary School. Peakview is a new school that is implementing a number of organizational and teaching strategies advocated by the school restructuring reform movement. Among those strategies is the infusion of more than 80 networked microcomputers and related technology and software. This evaluation study examined the impact of the technology on the school community. Using a variety of data collection instruments (e.g., classroom observation, surveys and interviews of school personnel and students), we found consistent evidence that technology plays an essential role in facilitating the school's goals. The technology is positively affecting student learning and attitudes. Teachers are using the technology to adapt to individual students' needs and interests, and to increase the amount and quality of cooperative learning activities. Students use the technology extensively for research and writing activities, as well as for instructional support in a variety of subject areas. Technology has changed the way teachers work, both instructionally and professionally, resulting in a net increase of hours and at the same time greater productivity, effectiveness, and satisfaction. A number of implementation factors are identified as contributing to the success of Peakview's use of technology. These factors form the basis of a set of recommendations for implementing technology successfully in other schools. This paper is a brief summary of the project; more complete findings are reported in a "short report" (about 50 pages) and the full report (about 200 pages plus appendices.)

Peakview Elementary School opened its doors to students in the fall of 1991. From the outset, school staff intended Peakview to reflect concepts of school reform. Examples of innovative organizational strategies include multi-aging, teacher teams across grade levels, and a commitment to problem-solving and cooperative learning activities. A key component of the reforms was a greater role of technology to support classroom activities. A substantial investment in computer and video resources was made, resulting in more than 80 Macintosh computers available in the school, most of them distributed in the classrooms. Classrooms presently house an average of 4–6 color Macintosh computers each. This is a significant increase in the quantity and quality of computers typically available in elementary school classrooms. Technology products—including optical laserdiscs and computer-based instruction—have replaced science, social studies, and math textbooks.

Most of the reforms implemented by Peakview staff are structural in nature and do not require significant additional resources. The increased reliance on technology for instruction, however, constitutes a more costly reform. In spite of redirecting monies normally allocated towards textbook purchases, the net cost to the school is substantial. A question posed by school staff is:

- Is it worth it? Does the technology support the innovative structures and goals of the school?

A parallel question relevant to district decisionmakers is:

- Would the Peakview use of technology be a model worth disseminating to other elementary schools in the district?

These are questions of worth, implying a tradeoff between costs and benefits. Although the present study is not a formal cost/benefits study, the questions above are still pertinent. ***Our purpose in conducting the study was to evaluate the impact of technology on the school.*** Of particular importance is the role of technology in furthering the school reform initiatives being undertaken. That is, ***does the use of technology impede, afford, or even accelerate the effectiveness of the teaching approach being implemented at Peakview?*** The findings of the study will evaluate the overall worth of the technology within the system; decisionmakers within the school and district should then be able to determine whether the added costs involved provide a justifiable return on investment.

The Study's Design

This is primarily a case study of Peakview Elementary School and its use of technology. A number of data-collection instruments were used to help provide valuable information concerning the school; these are discussed in the Method section below. The study relied heavily on written surveys and interviews of teachers and students.

The present study was designed and conducted to be a sort of "snapshot" of conditions at Peakview. To provide a context for understanding, comparison were made of two kinds:

Beginning vs. end of school year. Survey data were collected at two different times: August 1991—one month after Peakview's opening—and May 1992, toward the end of the school year. This allows some perspective on changes over the course of the school year.

Peakview versus other schools. To gauge in what respects Peakview differed from other schools in the district, three additional elementary schools were selected for comparison. Two schools were selected primarily for logistical convenience: Summit and Polton had staff members who were students within UCD's Division of Instructional Technology. These staff members agreed to collaborate with us in conducting the research. Summit has a computer lab of Apple IIgs computers, and very few computers in individual classrooms. Polton also has a lab, with a few computers in classrooms. Parallel survey data were collected at these additional elementary schools; no other data were collected from these schools. Dry Creek was selected because it was perceived to be similar to Peakview in that computers were integrated into classrooms, but different because the computers were Apple II's rather than Macintosh computers.

Shifts in Teaching Methods

Collins (1991), a noted cognitive psychologist, cited eight trends in changing teaching methods. These changes are supported by research in cognitive psychology. Collins notes that each of these changes in teaching method can be facilitated by technology. We have listed each trend below along with a brief comment relating the teaching method to technology.

1. ***A shift from whole-class to small-group instruction.*** Gearhart, Herman, Baker, Whittaker, and Novak (in press) observed a dramatic decrease in teacher-led activities when computers are used, from 70% to less than 10%.

Traditional Teaching Methods	Technology-Assisted Methods
Whole-class instruction	Small-group instruction
Lecture and recitation	Coaching
Working with better students	Working with weaker students
Less engaged students	More engaged students
Assessment based on test performance	Assessment based on products, progress, and effort
Competitive social structure	Cooperative social structure
All students learning the same things	Different students learning different things
Primary of verbal thinking	Integration of visual and verbal thinking

Table 1. *Trends toward constructivist teaching methods facilitated by technology (Collins, 1991).*

2. ***A shift from lecture and recitation to coaching.*** Again, Gearhart and colleagues (in press) found an increase in teachers serving as facilitators (rather than directors of behavior) when using computers, from 20% to 50% of class time. Collins (1991) comments: "The introduction of a third party, the computer, into the situation encourages the teacher to play the role of a coach, in much the same way that a piano encourages the teacher to play the role of a coach in a piano lesson" (p. 29). Schofield and Verban (1988a) found teachers using first-person constructions ("Let's try this") over second-person, didactic constructs ("You should do this") when using computers.
3. ***A shift from working with better students to working with weaker students.*** In traditional classrooms, teachers often carry on a conversation with brighter students who raise their hand; teachers often ignore slower students to avoid embarrassing them. With technology, that pattern is reversed: Schofield and Verban (1988a) found slower students receiving two to four times more attention from the teacher.
4. ***A shift toward more engaged students.*** A number of studies have demonstrated that students who work with computers exhibit greater task engagement, often to the point of fighting over computer between classes and after school. "To the degree that the computer supports long-term effort rather than short exercises...students become invested in the activities they carry out on computer" (Collins, 1991, p. 30).
5. ***A shift from assessment based on test performance to assessment based on products, progress, and effort.*** Teachers have traditionally relied on end-of-unit tests for assessment. Technology shifts assessment efforts from tests to effort and progress on projects, and on the final product. This, of course, poses new problems for teachers as they search for meaningful and reliable ways of evaluating work products.

6. ***A shift from a competitive to a cooperative social structure.*** A number of researchers have noted greater cooperation among students when using technology. For example, Harel (1990) studied 4th graders as they developed their own lessons to teach fractions to 3rd graders. She found students naturally sharing ideas and helping each other solve problems in their programming.
7. ***A shift from all students learning the same things to different students learning different things.*** A number of studies have shown how technology can support students as they tackle various parts of a complex project, each contributing to a larger final product. What this means is that students are working on separate aspects of a problem. Students working on different learning goals can be a logistical nightmare without technology to maintain focus and manage information.
8. ***A shift from the primacy of verbal thinking to the integration of visual and verbal thinking.*** Visual media—television, film, and computers—have begun to gain parity with abstract text as a primary means of learning in our day. Lectures, multiple-choice tests, and recitation of knowledge become less relevant methods when faced with technology-based alternatives.

In other words, society in general and education in particular are coming to value a certain approach to education. There is some evidence that technology can help education practice move in those valued directions. This line of thinking influence the design of the present study; the reasoning was: Technology can be justified to the degree that its use is found to facilitate instructional methods and learning goals that are valued by the school and/or the district.

METHOD

In consultation with Peakview and Cherry Creek leadership, we developed a list of research questions to be addressed by the study. These questions then drove the development of data-collection instruments, and provided a structure for reporting findings. The questions were based on:

- the stated goals and objectives of the school;
- the expressed need of school and district staff;
- the expected impact based on the review of literature.

Instruments

The lengthy list of evaluation questions suggests that a variety of data-collection methods be used; hence, a number of instruments for data collection were developed and used. The major data collection instruments are listed below.

August 1991	Baseline survey.
May 1992	Main survey (administered at Peakview and 3 comparison schools) • Primary student surveys. • Intermediate student surveys. • Teacher surveys. • Staff surveys.
May 1992	Peakview teacher/staff interviews.
May 1992	Peakview student interviews.
May 1992	Peakview teacher logs and written reports.

Depending on the data source, a number of different strategies for interpreting the data were used. For surveys, bar charts were developed to display the means and distributions of responses to questions; responses were separated according to school, with Peakview separated from the remaining schools to allow clear comparisons. These bar charts allow a visual comparison of the response patterns between Peakview and the comparison schools. Line charts were also developed comparing the mean responses of the four schools. Where possible, chi square (χ^2) or analysis of variance (F statistic) were calculated to compare responses across schools.

Responses to open-ended questions from the survey and interview questions were treated similarly. Data were coded into qualitative categories; these categories were then used for reference and retrieval. In addition, where appropriate counts were conducted on the frequency of different response categories; the frequency breakdowns of these counts are presented in the findings.

SELECTED FINDINGS

This section reports the findings of the study in highly abbreviated form. Graphs and tables comparing Peakview with comparisons schools are presented in the full report.

Use of Technology

Prior to coming to Peakview, teachers showed a typical range of prior experience in using technology. In August 1991, Peakview teachers most commonly reported "sometimes" to the statements:

> I have used computers before with children in my classroom.
> I have used computers before with children in school (computer lab, etc.).

Since coming to Peakview, teachers find themselves using technology daily in their classrooms. Peakview students spend roughly twice the time on technology as a students in comparison schools. Teachers keeping a weekly log reported spending 39% of students' worktime spend using technology. Peakview students confirm this report of greater technology use. Peakview elementary students report using computers several times a week, whereas comparison students average about once or twice a week. Primary students report similar usage patterns.

Comparison to teachers at comparison schools, Peakview teachers report significantly more use of technology in all major areas:

- word processing ($p < .001$),
- authoring, ($p < .06$),
- art and graphic activities ($p < .001$),
- instructional software ($p < .01$), and
- laserdisc viewing ($p < .001$).

Teachers report greater use of alterantive media, greater use multiple modalities. Student self-report data corrobate this finding. Contrary to sales pitches, teachers report working longer hours as a result of the technology. On the other hand, many teachers report having more time for small-group and individualized activities.

The technology available at Peakview affects the kinds of instructional strategies teachers use in the classroom. Peakview teachers overwhelming agree that technology makes their teaching more effective. Consistent with Collins' (1991) analysis of trends in education, we found that technology enables teachers to succeed in areas that are important to them, summarized in Table 2 below.

Learning Goal	Importance to Teachers	Effect of Classroom Technology	Peakview versus Other Schools
Accommodate different learning styles	Very high priority	Moderate to heavy	Peakview higher ($p < .001$)
Self-directed learning	Top priority	Heavy	Peakview higher ($p < .001$)
Accommodate students working on multiple learning goals	Top priority	Moderate to heavy	Peakview higher ($p < .001$)
Students teaching themselves and others	Very high priority	Moderate to heavy	Peakview higher ($p < .01$)
Student research skills and independent access of information	High priority	Moderate to heavy	Peakview higher ($p < .01$)

Table 2. *Teacher priorities of different learning goals, and how technology impacts on those learning goals.*

Peakview teachers report that technology affects other desirable educational goals and strategies, including:

- cooperative learning activities (whereas non-Peakview teachers reported very little effect of technology on cooperative learning);
- productive time on task;
- student attentiveness.

Teacher attitudes

At the beginning of the 19992 school year, a survey asked Peakview teachers to contrast their prior conceptions to present conceptions toward technology:

[I used to]...	*watch.*
[Now I]...	*try.*
[I used to]...	*look for the "expert" to help kids who were stuck. .*
[Now I]...	*try things out for myself -and by doing it daily several times, I'm learning some procedures by heart!*
[I used to] ...	*see the potential of computers for other people*
[Now I]...	*see the potential for myself!*

[I used to]... avoid computer at all cost.
[Now I] ... only avoid them during Bronco games.

These responses clearly indicate a shift toward more receptive, positive attitudes toward technology. Later in May, 20 of 21 responding teachers at Peakview reported that their attitudes toward technology in the classroom have changed substantially over the past year. Teacher interviews yielded the same finding:

> *I may have been a little skeptical, at first, but I am a true believer in the vital role computers have in our educational system!* Nora, Kindergarten teacher

> *My goal is to learn more! I'm getting over a lot of my "fears" about computers, but there's an awful lot I still need to learn! I feel a comfort level settling in, but I need more information!!! More time to learn!!!* Nora, Kindergarten teacher

> *What I will always remember about this year is the realization that teachers need not be computer wizards...just learners.* Matt, intermediate teacher

Peakview teachers report higher "comfort levels" than their counterparts in using word processing, videodisc viewing, and arts and graphics programs. With some exceptions, teachers at all four schools reported relatively low comfort levels using databases, spreadsheets, and programming. Peakview students received more encouragement from their teachers in using technology, and said their teachers seemed to enjoy using the technology. Virtually all of the data we collected in the study served to corroborate the finding of positive teacher attitudes at Peakview.

Student Achievement

Eighteen of 22 Peakview teachers agreed that student achievement is increased when they use technology. The remaining four were undecided; none disagreed with the statement. From teacher interviews:

> *I think they are excited about learning. It's a new avenue...they are doing writing, [and] reading things I didn't think first- and second- graders could do. It's interesting...I have kids who are working on projects [and] units...the learning is more in depth...more opportunities, not just a book and paper.* Charlotte, primary teacher

> *Supermunchers—the kids taught themselves new words so they'd be able to do it. They really have made themselves learn the new words.* Ginny, primary teacher

> *Achievement gains in reading and writing are very pronounced, especially with kids on the low end.* Adam, intermediate teacher

> *I've never had a class that has known all the letters. This year every child in my class knows every letter of the alphabet. A lot of it is due to the computer. I can't say exactly, but I feel certain that it is.* Mary, Kindergarten teacher

Technology is a good way to:	Peakview Teachers	Non-Peakview Teachers	School Differences
Learn basic skills	Agree to Strongly Agree	Agree	ns
Help students learn to work in small groups.	Agree to Strongly Agree	Agree	ns
Access and use information	Strongly Agree	Agree to Strongly Agree	ns
Learn oral and written communication skills	Agree	Undecided	Peakview higher ($p < .05$)
Help students learn to research and report on a topic	Strongly Agree	Strongly Agree to Agree	ns
Learn problem-solving skills	Agree	Agree	ns

Table 3. *Teachers as a way to teach different learning outcomes.*

Student Attitudes

Attitudes toward school. Peakview students generally like school, with a majority responding that school is not too easy and not too hard, but rather "just right." They say technology makes school "a lot" more fun. Peakview students report liking school "a lot more" because of the technology. Non-Peakview intermediate students differ markedly ($p < .001$), with responses averaging "a little more."

Attitudes toward technology. Peakview students were asked in the August Baseline Survey several questions aimed at gauging their feelings toward the technology available at the school. Intermediate students generally agreed about the important of learning to use computer, about their parents' endorsing their learning, and that technology was a good way to learning something new.

Intermediate students at all four schools uniformly reported wanting to learn more about technology, with Peakview students showing markedly greater enthusiasm ($p<.001$). Primary students in focus interviews at all four schools unanimously agreed with the same statement. Students at the four schools also concurred that learning about technology was an important goal. Again, Peakview intermediate students showed a stronger conviction than non-Peakview students ($p<.05$).

Students across the four schools reported a preference for technology-based learning over textbook-based learning. Peakview intermediate students expressed stronger agreement than non-Peakview students ($p<.05$). This confirms intermediate student reports in the August Baseline Survey.

Teachers confirmed positive student attitudes regarding technology.

> *They love the computers! For Free Choice Center, I always have to say "Who wants to go to the computers first?" It's the most favored thing that they like to do.*

> *They love the technology. They have a kind of 'I can' attitude.*

Students spoke for themselves about their attitudes toward the technology:

> *Technology is really a outstanding thing. I hope I am good in technology. We didn't use computers much in our old school. Some of the people in our class are really good typers on the computer. I really like my school. I'm glad we have a lot of computers.* Brittany

> *I used to write and write. But I never had any pleasure with it. I would cherish the times I got to go to the computer lab. I never dreamed of using as cool technology as I do now.* Anne

> *I love technology and praise this school for preparing me for tomorrow's society. I am very scared about tomorrow, but I am prepared and confident in my peers. I wish to have a future part in the technology market. I also think that future school should have this privilege.* Kevin

Attitudes toward learning. Peakview students were asked in the August Baseline Survey questions related to technology and learning. Students at all grade levels report agreement that technology will help them learn. Peakview teachers observed that students are highly motivated to stay on task and learn with technology:

> *The kids are affected. Can I stay in recess, can I stay late? We have such a short recess period, I wish we had more opportunities to do more.* Michael, intermediate teacher

> *...98% of the kids will choose to stay in and work with computers rather than go outside for recess .* Nora, Kindergarten teacher

> *Kids come early, stay late, stay in at recess.* Brad, Kindergarten teacher

Students commented:

> *I like computers a lot and I do as much as I can on computers. We've got a computer at home. It's a quicker way to do things. It's fun and it's good to learn with.* Charles Johnson

> *If we didn't have technology everyone would be bored...there'd be nothing to do.* Mathew

Attitudes toward self. When asked if technology makes them feel good about themselves, Peakview intermediate students agreed more strongly than non-Peakview students ($p<.001$). Primary students at all four schools also reported that using technology makes them feel good about themselves. Most (83%) report computers being "easy."

Interviews of Peakview intermediate students illustrate the positive effects technology can have on some children's self-concepts:

> *Technology has really been a very good experience for me this year. I've been getting better grades, in which I've been excepted into the G.T. program and I think it's do to the technology because you can learn stuff with technology like laserdiscs, G.T.V., and CD-ROM. I will be going to Thunder Ridge next year and hope I'll have at least on class (not counting computer class) that has at least 6 computers in it like Peakview. I've done some projects without technology and some with it, and it was much easier with the technology.* Charlotte

> *My feeling about technology are...that since so many computers are at Peakview I seem smarter. The computers are like electronic textbooks Except they are tons more fun..* Elizabeth

Intermediate Peakview students, asked in August if they were worried about making mistakes on the computer, responded diversely. The fact that so many students reported concerns about errors suggests that, even for children who view computers as easy and view themselves as good at computers, making mistakes can still be a concern.

A survey response by a fourth grader further illustrates how many children feel about the technology at Peakview:

> *I used to not be alod to use technology that mach at all. I felt relly dome when I was at my old school. But now I think technology is grand but in a way it is hard. So well I stell love technology and howe it work's.* Heather

In summary, students' self-concepts are affected by a number of factors. Trying to isolated the effects of technology is difficult. The great majority of students view technology as easy, particularly Peakview students. However, a number of Peakview students, at the beginning of the year, reported worrying about doing something wrong on the computer. It seems that there may be some students with concerns about the technology and their confidence in using it. On the positive side, students at all four schools generally agreed that technology make them feel good about themselves. Eighty-six percent of Peakview intermediate students agreed the statement. This indicates a strong number of students whose self-concepts are likely helped by through working with technology.

Student empowerment. An important educational goal is to help children come to feel in control of their own learning. Taking charge of one's learning—independent of the teacher's behavior and the school environment—is often not entirely achieved until high school. Because technology-based activities can often take the form of independent or cooperative research activities, we were interested in gathering information on this question.

Intermediate students across the four schools generally agreed with the statement,
I like technology because the teacher doesn't always have to help me . Primary students showed a similar profile of agreement to the statement. Students generally agreed with the statement *I like to make my own choices about how I use the technology,* although a number of students were "unable to judge." Primary students at the four schools concurred. Responses were similar to the question, *I like to think of my own ways to use technology.*

Attitudes of children with special needs. The motivation and attitudes of certain children are especially important when considering educational innovations. For example, if most children had positive attitudes toward a new strategy, but low-achieving children hated it, that finding would be cause for concern, even if the strategy were generally beneficial. Teachers were asked specifically about technology's potential in enhancing the self-esteem of at-risk students. Staff members at all four schools agreed that technology can enhance the self-esteem of these children; Peakview staff members strongly agreed with the statement.

Students limited physically seem also to be helped by the technology. One advantage is in the ease in interacting with the keyboard for students who have difficulty controlling their fine motor movements. A Peakview special education teacher commented:

> *Technology has changed my life and the lives of my students, almost entirely with positive changes. First of all, most of "my" kids have difficulty with reading and writing, and they are much more motivated by such avenues as computers and laserdiscs to read and write. In writing, for example, students can pull up a variety of pictures for inspiration on the computer, then enjoy the increase of their keyboarding skills and their professional production as they write their stories. For students with fine motor difficulties, who find it hard to produce legible writing the computer opens a whole new avenue of flexible expression.* Gerri, K–5 special education teacher

> *Perhaps what I've noticed the most is the success and growth it gives children when they might not be receiving it from other academic areas. Having a special needs child in my classroom is proof of that. It is through the computer that he is able to choose spelling words, read and follow a book on the CD-ROM and most importantly be able to communicate through a keyboard using pictures and sound. I know that as he continues to use technology he will become more proficient, meaning he will become a better communicator with those around him.* Charlotte, primary teacher

One teacher commented on lower-achieving students and the help technology can be:

> *I have seen "non-readers" become avid consumers of written information. I have seen "non writers", especially those hampered by poor fine motor skills, show tremendous pride in their obvious growth as writers. Kids who, eight months ago, would have run at the mention of research projects, now actively pursue areas of interest ranging from American political figures to zoology.*

Summary of the Findings

The table below outlines the various effects we have found at Peakview Elementary. The table does not include the strength of evidence for the various findings, but it does provide a handy overview of the various factors affected by technology at the school. Although the study identified a number of areas that need refinement, we could not identify a general impact area where the technology was perceived to have a negative impact.

Impact of Technology On:	**Strongly Positive**	**Positive**
Use of Technology	X	
Use of multiple modalities	X	
Use of media	X	
Impact on Teaching		
Accommodating ability levels	X	
Small group instruction		X
Competitive vs cooperative social structures		X
Verbal and visual learning media		X
Time on technology	X	
Time on task	X	
Self-directed learning	X	
Accommodating multiple learning goals	X	
Accommodating learning styles		X
Students as teachers	X	
Information access and research activities	X	
Changes in teacher work	X	
Teacher attitudes		X
Teacher comfort levels		X
Computer coordinator	X	
Taking computers home	X	
Computer as a stimulus to change		X
Teacher perceptions of students		X
Self-concepts as competent professionals		X
Student achievement		X
Attainment of basic skills		X
Access and use of information	X	
Problem-solving skills		X
Oral and written communication skills		X
Researching and reporting	X	
Student's perspective		X
Small-group work		X
Other forms of achievement	X	
Student attitudes	X	
Towards school	X	
Towards technology	X	
Towards learning	X	
Towards teachers	X	
Towards self	X	
Student empowerment	X	
Special needs students	X	

Table 4. *Summary of the impact of technology at Peakview Elementary School.*

Conclusions of the Study

1. ***Students and teachers are using the technology.*** The available evidence suggests that the technology is being used heavily at Peakview Elementary. Generally, the kind of use includes word processing, graphics, instructional software, and laserdisc viewing. Students use technology in finding information, researching and writing about topics, and in problem-solving activities.
2. ***Technology is changing classroom practice.*** Peakview teachers overwhelmingly prefer 4–6 computers in the classroom over computer labs. Technology has stimulated innovation in the way subjects are taught; several teachers report adapting their teaching to better integrate technology into different subjects. Other teachers report a desire to continue learning more about the technology, in order to continue changing their classroom practices. Teachers report working more hours because of the technology, and having more control over their work.
3. ***The technology has changed teachers' beliefs and attitudes.*** Peakview teachers underwent an attitude shift in their first year using technology at Peakview. They came to see technology as a powerful tool to facilitate learning in elementary children. They believe that technology can be a vehicle for accomplishing many of the learning and instructional goals that are important to them, such as problem-solving skill, cooperative learning, independent research skills, and individualization according to learners' needs. They have gained confidence in their own abilities to use computers and other technologies.
4. ***Students learn effectively using the technology.*** Students are showing tentative learning gains in a variety of areas. Their skill at using technology is obviously improved. Some teachers report reading and vocabulary improvements in early grades. Students do more editing and revising of written work using word-processing tools. Spell checkers are only sparingly used by students. A number of intermediate students are using the technology for a variety of independent or small-group projects, including:
    - Combining paint graphics and word processing;
    - Incorporating scanned and clip-art graphics;
    - Authoring HyperCard projects;
    - Using CD-ROM and optical laserdisc information references;
    - Incorporated CD-ROM and laserdisc sequences into HyperCard projects.

    Teachers and students report greater student interest and initiative in completing research projects.

5. ***Students are motivated to learn with the technology.*** Students experience increased independence and empowerment as a result of the way technology is used. Teachers report that students work more productively with computers. Student attitudes are positively affected by technology, toward:
    - school,
    - technology,
    - learning, and
    - themselves.
6. ***Technology is a vehicle for many of the school's reform initiatives.*** Multiaging (having children K–3 in the same classroom) becomes more manageable when technology is used.
    - Process instruction in writing is feasible when editing and revisions can be done on computer.

- Independent research can be more easily accomplished when electronic forms of references are consulted, and when student data is stored and manipulated on computers.
- Technology-related projects lend themselves well to cooperative learning groups. Students can collect projects into electronic portfolios, allowing for alternative, authentic assessments of their learning.

Each of these initiatives is part of Peakview's innovative philosophy of elementary education. There is no question that without the technology, many of these practices would go forward. However, access to the technology improves the likelihood that these reforms will succeed.

7. Key elements of ***successful implementation*** include:
    - ***Computers abundantly available in the classroom.*** Each classroom houses 4–6 color Macintosh computers; computers are often shared between adjoining classrooms to allow more flexible use of resources. According to teachers, the number of computers in the classroom, and teachers' and students' easy access to them, is a powerful factor contributing to successful implementation.
    - ***Shared commitment and vision of school reform with technology as an essential component.*** The amount of work required to successfully begin a school with a number of innovations should not be underestimated. The Peakview community—particularly the teachers and administration—articulated a vision for the school, and they committed to making that vision happen. The entire staff bought in to the program, and worked had to overcome the many obstacles and challenges encountered along the way. An atmosphere was cultivated that encouraged offering mutual support and sharing resources.
    - ***A supportive district and principal.*** Peakview received the support of district administration in developing an innovative set of values and methods for elementary education. The principal supported the use of technology at the school, and enthusiastically learned to use the Macintosh along with the rest of the staff. The leadership and commitment of district- and building-level administrators created conditions conducive to success at the school.
    - ***A strong computer coordinator.*** Peakview has one teacher assigned full-time to technology leadership and support. This position seems to be a critical component of the school's implementation of technology. The computer coordinator seems to give other teacher the courage to "charge ahead" in the use of the technology. Hardware and software systems are maintained and managed; inservices are provided to staff and students; troubleshooting help is provided for problems as they arise.
    - ***Early and thorough teacher training.*** Before the school opened, teachers received training on Macintosh operating system, *Microsoft Works*, and instructional software to be used in classes. Inservice lessons have been regularly made available to teachers and students. This access to expertise seems to have been very helpful to teachers.
    - ***Taking computers home.*** Following initial training in the spring of 1991, each teacher was given a computer to take home for 6 weeks. According to many teachers, this allowed them time to become comfortable with the technology before school started. Many teachers reported receiving tutorial help from their children.
    - ***User-friendly systems.*** The color Macintosh LCs at the school have contributed to the attitude change among many teachers. High-quality software is another factor in the school's successful implementation.

Recommendations to the School

1. Continue inservice training, particularly informal lessons with teachers and students attending together.
2. Train teachers in uses of database, spreadsheet programs, and other tools.
3. Continue computer coordinator position.
4. Periodically perform a self-study to assess progress, set priorities, spot trends, and establish strategic goals and plans.
5. Build regular maintenance and upgrade costs into regular school budget.
6. Continue developing electronic portfolios and other authentic assessment methods.
7. Develop improved assessment measures to track performance gains over a period of years.
8. Continue to develop electronic-mail (e-mail) and telecommunications capabilities.
9. Continue to cultivate parental involvement.
10. Find more problem-solving software, particularly in science.
11. Carefully implement cooperative learning activities, ensuring equitable workload among students and efficient use of time.

Recommendations to the District

1. Use Peakview as a model for other elementary schools in the district.
2. Perform a cost/benefits analysis to determine:
    - if Peakview technology-related outcomes are highly valued;
    - if the value of those outcomes justify the additional cost of the technology.
3. Incorporate objective measures of Peakview's performance into the data provided by the present study.
4. Measure student competencies throughout the district.
5. Continue to support Peakview as a prototype lab to try out new technologies and methods.

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Title:

Thoughts, Feelings and Actions: Integrating Domains in Library Instruction

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Thoughts, Feelings and Actions: Integrating Domains in Library Instruction

Presentation Handout

This presentation describes a framework for library instruction which integrates learning in the cognitive and affective domains. Central to this instruction is the use of an overall strategy called FOCUS, FORMAT, FIND and EVALUATE. Emphasized will be a demonstration the use of a FocusFramework which explores the problem formulation stage of research through a cooperative group activity. Although this instruction was designed to be used with first-year college composition classes, the strategy and Focus Framework have been adapted for use in a wide variety of other academic library instruction classes.

Background Concerns of Library Instructors

- Do students have overall concept of the research process?
- Does library instruction help them to develop this overall concept?
- Does library anxiety get in the way of library instruction?
- Can an emphasis on problem formulation give students a "jump-start"?
- Does library instruction have an effect on quality of the research paper?

Voices of the Experts

- Kuhlthau's concept of "research process orientation"
- Mellon's concept of "library anxiety"
- Tuckett & Stoffle's description of library research as problem-solving
- Nahl-Jakobovit's work in domain-integration in library skills development

Cognitive Strategies Instruction Designed

- First-year college composition course
- Three days; 50-minute periods
- Uses a cognitive framework: FOCUS, FORMAT, FIND, EVALUATE
- Addresses affective objectives at each stage of research
- Emphasizes problem formulation
- Incorporates group activities and cooperative learning
- Aims at intermediate and long-term goals

Research Study Designed

- Compares traditional lecture-based library instruction with cognitive strategies instruction
- Nonequivalent control group design with intact classes
- Pretest / Posttest of research process orientation, library anxiety, library attitudes
- Post-instruction measure of topic and title development (problem formulation)
- End-of-quarter measure of adequacy of research paper bibliographies

High Expectations

- More focused problem formulation
- Lower anxiety
- More positive attitudes
- Increased research process orientation
- Better research papers

The Results

- Most expectations met
- Successful adaptation to other courses
- A completed dissertation: A Cognitive Strategies Framework for Domain-Integrated Process-Oriented Library Instruction: The Effects on Research Process Orientation, Library Anxiety, Attitudes and Research Products of College Students, 1992

Summary of Performance Results of Hypotheses Testing

Dependent Variables	Pretest Differences Between Groups	Posttest Differences Between Groups	Gain Differences Between Groups	Gain Within Cognitive Strategies Group	Gain Within Traditional Group	Hypotheses Confirmed
Research Process Orientation	nsd	<.0001	<.0001	<.0001	<.01	yes
Library Anxiety	<.01	nsd	<.002	<.0001	nsd	yes
General Attitudes	nsd	nsd	<.01	<.0001	nsd	yes
Research Bibliographies	n/a	<.0001	n/a	n/a	n/a	yes
Usefulness of Instruction	n/a	nsd	n/a	n/a	n/a	no
Topic/Title Development	n/a	<.05 / nsd	n/a	n/a	n/a	yes / no

Overall, the cognitive strategies instruction was successful in improving research process orientation, reducing library anxiety, and improving general attitudes. Evidence for the effectiveness of the instruction was shown most impressively in the strong performance of the cognitive strategies group on the research paper bibliographies.

Evaluators observed more highly developed research paper topics among the cognitive strategies group, but did not find group differences in level of title development. The measure of perceptions of immediate usefulness of library instruction did not detect any significant group differences with both groups indicating strongly positive perceptions.

It is hoped that the empirical evidence of the effectiveness of the domain-integrated process-oriented instruction used as a treatment in this study will encourage librarians to design and implement such instruction. Libraries should make it their role to teach not only specific sources and procedures within the local library, but to teach the processes of life-long self-education in a worldwide, electronic environment. In this global view, the library is no longer the context for the learning process; instead, the context is the information society itself.

Thoughts, Feelings and Actions: Integrating Domains in Library Instruction

RESEARCH SUMMARY, DISCUSSION, AND CONCLUSION

Summary

The purpose of this study was to compare the effects of two methods of academic library instruction on research process orientation (a construct developed by Kuhlthau), library anxiety (a construct developed by Mellon), student performance on the complex problem-solving task of researching and compiling a research paper bibliography, research paper topic and title development, perceptions of the immediate usefulness of the library instructional sessions, and attitudes about library instruction in general.

Two instructional treatments were designed for use in the library skills component of a college-level English composition class. Both the traditional treatment and the cognitive strategies treatment were designed to support achievement of the same terminal goal, that of completion of a successful, documented, library-based research paper. However, there were considerable differences between the treatments in both instructional content and teaching method.

The traditional instruction was resource-oriented and consisted of lectures and demonstrations which presented the basic tools and technologies used in library research. This type of procedural instruction is common in academic library settings. The emphasis of the instruction was to teach standardized procedures for student interaction with the library environment. No emphasis was placed on the process of research, except for a recommendation to start with general sources and proceed to specific sources. Affective and metacognitive learning were not addressed.

The cognitive strategies instruction was process-oriented, that is, it was based on and emphasized the research process itself rather than focusing on the use of specific information sources. The design of this instruction was based on a theoretical framework which combined conceptual models representing information searching as a type of problem-solving with grounded theories concerning affective and metacognitive aspects of information searching. The instruction was designed to integrate development of skills in all the domains of learning: cognitive skills for problem-solving, psychomotor skills for navigating in specific information environments, metacognitive skills for self-monitoring, and affective skills for self-motivation.

The subjects for this study were 190 undergraduate students enrolled in a required English composition class. The research design chosen for this study was a non-equivalent control group design with intact classes randomly assigned to the cognitive strategies group or the traditional group. The researcher, an experienced library instructor, taught all sections using a lecture and discussion format.

Several different types of evaluation instruments were employed in this study. The pretest, administered at the beginning of the quarter, included a survey which collected background demographic data. The pretest also included scales which measured research process orientation, general attitudes towards library instruction and library anxiety. Immediately after instruction, held mid-quarter, students were asked open-ended questions (on topic and research paper title development) and survey questions which measured student perceptions of the immediate usefulness of the library instruction sessions. The posttest, administered at the end of the quarter, repeated the research process orientation, general attitudes, and library anxiety scales. Finally, students' research paper bibliographies were scored at the end of the quarter using a scale which measured adequacy of student performance. Copies of these instruments and protocols for their administration can be requested from the researcher.

It was expected that the cognitive strategies treatment would have more positive effects than the traditional treatment on research paper topic and title development, and on student perceptions of the usefulness of the library instructional sessions as observed immediately after instruction. It was also expected that the cognitive strategies treatment would result in higher student gains over the course of the academic term in research process orientation, attitudes about library instruction in general, anxiety reduction, and performance on the term paper bibliography.

Independent sample *t*-tests were conducted to determine differences between treatment groups on the research process orientation, library anxiety, and general attitudes measures of both the pretest and posttest. Additional independent sample *t*-tests compared gain scores between treatment groups on each of these measures. Paired sample *t*-tests were conducted on each portion of the pretest and posttest to determine the significance of gains in research process orientation, library anxiety and general attitudes within each treatment group. The ratings of student performance on the research paper bibliographies were also tested using an independent sample *t*-test, as was the student perception of the usefulness of instruction. The categorical data produced by measures of research topic and title development was analyzed using chi-square to determine differences between the groups.

A chi-square analysis of the Background Survey data revealed no significant differences between the treatment groups on such demographic factors as age, race, sex, academic status and grade point average. Independent sample *t*-tests conducted on the pretest data showed no differences between the groups in research process orientation or general attitudes. There was, however, evidence that the traditional group demonstrated significantly lower library anxiety than the cognitive strategies group on the pretest.

Overall, the cognitive strategies treatment was successful in improving research process orientation, reducing library anxiety, and improving general attitudes. Evidence for the effectiveness of this treatment was also shown by evaluator judgements of more focused research paper topics and titles among the cognitive strategies group and especially, in the strong performance of the cognitive strategies group on the research paper bibliographies. The measure of perceptions of immediate usefulness of library instruction did not detect any significant group differences with both groups indicating strongly positive perceptions.

Discussion of Findings

Research Process Orientation

The results of this study do support the hypothesis that research process orientation (RPO) for both treatment groups would increase significantly from the pretest measure at the beginning of the academic quarter to the posttest measure at the end of the quarter. The data also clearly indicate that the cognitive strategies group gained in RPO to a significantly greater extent than did the traditional group.

An increase in research process orientation from the beginning of the quarter to the end was to be expected simply due to the experience of conducting a research paper project from start to finish. Kuhlthau's studies (1988a; 1988b; Kuhlthau et al., 1990), which measured research process orientation at the beginning, middle and end of the research paper project, found an increasing level of RPO throughout the project. Kuhlthau's subjects, however, did not receive any kind of library instruction during the project. The present study is unique in measuring RPO in relation to library instruction.

The finding that library instruction which was specifically process-oriented and domain-integrated was more effective in increasing the RPO of students is significant. The emphasis in the instruction on the affective and metacognitive elements of the research process in the framework of the cognitive strategy, FOCUS, FORMAT, FIND and EVALUATE, seemed clearly effective in increasing the RPO of the students. This finding supports a body of research which indicates that students can be helped to "learn how to learn" through direct instruction (Derry & Murphy, 1986). While direct experience of the research process is likely a factor in increasing research process orientation, the findings in this study indicate that process-oriented instruction may influence the development of RPO. Librarians who provide instruction for beginning researchers should be encouraged by these findings to design instruction which presents research as a process, and makes students aware of the integration of thoughts, feelings and actions inherent in the process.

Since this was the first study to examine changes in research process orientation in relation to library instruction, there is ample opportunity for researchers to explore this issue further. The present study looked at research process orientation as one of six dependent variables, and based measurement of it on only fifteen survey items. Future studies should better isolate this variable from other influences, and base measurement of it on a larger number of items in order to increase the reliability of the scale.

The research process as experienced by undergraduate students is being studied in a number of ways, both qualitative and quantitative. Fister (in press) has conducted in-depth interviews with students who were identified as having successfully completed research projects of various kinds. Her initial findings suggest that the students' experiences in finding a focus, using evidence, and articulating findings are strikingly different than the strategies frequently taught in library instruction. Content analysis of oral or written library user comments are being used by Nahl-Jakobovits and Jakobovits (1992) to develop user-based objectives in the affective, cognitive, and sensorimotor domains. Outside the field of library science, Carley and Palmquist (1992) are using computer-based tools to analyze written and spoken texts for the purpose of representing mental models of people in social situations. Using this technique, the researchers have extracted mental models of undergraduate students at the beginning and end points of a research paper assignment and compared the computer-generated maps.

Use of techniques such as those described above, combined with the basic work done by Kuhlthau, could lead to a deeper understanding of how the research process is carried out by individuals, and how it changes over time and with experience. Such an understanding would be valuable not only for librarians and library instructors, but for designers of instructional products. More and more reference books are being published in electronic formats such as CD-ROM; more information is available on electronic databases everyday. These sources, with their tremendous potential for interactive searching, should be designed with the human information searching process clearly in mind.

Library Anxiety

The results of this study do support the hypothesis that library anxiety for both treatment groups would decrease from the pretest measure at the beginning of the academic quarter to the posttest measure at the end of the quarter. However, while the decrease for the cognitive strategies group was significant, that of the traditional group was not. The data indicate that library anxiety in the cognitive strategies group was reduced to a significantly greater degree than in the traditional group. These findings support research which has shown that strategies training in metacognitive awareness (Meichenbaum, 1977) and the use of group activities (Ramey, 1985) have had positive effects on learner attitudes.

These findings, however, must be looked at in light of significant differences between the groups on the pretest library anxiety measure. Since the groups were not shown to be statistically equivalent at the outset, conclusions about the effects of the treatments should be looked at with caution.

Although the library anxiety scale was judged to be adequately reliable with a Cronbach Alpha Coefficient of .87, an item by item analysis shows a great deal of variability in student responses to individual items. Mellon (1986) had identified several probable sources of library anxiety including perception of self as inadequate, perception of others as more adequate, fear of technology, fear of approaching mediators, and generalized feelings of discomfort in unfamiliar situations. The items on the library anxiety scale were written to reflect these probable sources. From a visual examination of the data, it appears that there is wide variation in what students find to be anxiety-producing. Two students with exactly the same scores on the scale may not overlap at all in their perceptions of anxiety-producing situations.

This observation may have more than one explanation. It is likely that the library anxiety scale itself needs further study and refinement. Although the content of the items is based on theoretical principles and empirical evidence, the items themselves were written for this study and have not been validated by repeated use. Additional studies using these items, and others developed for the Library Anxiety Test Bank (available from the researcher), will help to resolve the question of the validity and reliability of the library anxiety scale.

Another possible explanation is simply that there is a great deal of variance in what people find threatening in a library environment. This explanation is supported by the daily observations of reference librarians. Although the acts of asking a librarian for assistance and threading a microfilm reader are quite different, they are both very common sources of anxiety among library users. It may be that the most valuable use of a library anxiety scale like this one would be for needs assessment purposes at the beginning of a course. Students identified as having certain types of library anxiety could be directed to individualized or small group activities which would assist in relieving that source of the problem.

General Attitudes

The hypothesis that students' attitudes about library instruction in general would improve from pretest to posttest was supported only for the cognitive strategies group. The cognitive strategies group did improve significantly from pretest to posttest, and did improve significantly more than did the traditional group. The traditional group showed an insignificant decline in attitudes.

The improvement in the attitudes of the cognitive strategies group supports using an instructional method which focuses on teaching the library research process, and, while doing so, includes relevant information about the library building, technologies, and library staff. Attitudes about libraries are difficult to change, especially since such attitudes have been developed over years of schooling and library use. According to Gagné (1985), in order to change attitudes, both the internal and external conditions of learning must be met. The internal conditions demand that the student have a conceptualization of the object, event, or person to which the changed attitude will be directed. In the case of negative attitudes towards libraries, it can be seen that there are multiple objects toward which those attitudes are directed. They include the building itself, the multiple technologies contained within it, the library staff, and more. But these negative attitudes are also directed toward the events, actions and situations of the library research process itself. The cognitive strategies treatment may have been successful due to that fact that the concept of the research process, an unfamiliar concept to most undergraduates, was taught directly.

Caution should be used in interpreting these results due to the small number of items (5) on the general attitudes scale. Scores for both groups represent moderately positive attitudes on both the pretest and posttest, with one item accounting for nearly all the negative responses. This item was "Classes which teach the library research process are interesting". Since the realm of library instruction included any class a student had ever participated in, the 49% answering "seldom" or "almost never" on the pretest was not surprising. Library instruction has a common reputation for not being interesting. That only 42% of students gave those answers on the posttest was only slightly heartening.

Problem-Solving Performance: The Research Paper Bibliography

An important outcome of this study was the strong support for the hypothesis that concerns student performance on the problem-solving task of researching and compiling a research paper bibliography. Results of the study indicated that the research paper bibliographies of the cognitive strategies group were scored significantly higher on the Bibliography Rating Scale by two expert evaluators than were the bibliographies of the traditional group.

These results support the likelihood of an initial positive effect of giving students a problem formulation strategy, as suggested by Mellon (1984), as well as the positive cumulative effects of strategies through practice over time (Derry & Murphy, 1986). This study, like others which compared modes of instruction, supports the positive effect of cognitive strategies training on library skills (Arp & Wilson, 1984) and student research products (Kohl & Wilson, 1986).

This finding is significant in terms of both research and practice because of its relevance to a central issue concerning the effectiveness of library instruction. Much evaluation of library instruction has examined student perceptions of the value of instruction, student attitudes, preferences for teaching methods, and assessment of skills in using specific library resources. It has been assumed that library instruction contributes to better works of scholarship produced for actual course assignments, but there has been little empirical evidence of this contribution. This study presents such evidence using data gathered by a proven methodology (Dykeman & King, 1983) in which experts employed their professional judgement to evaluate the student bibliographies according to standardized criteria.

These results should provide some encouragement to practitioners in library instruction. Domain-integrated process-oriented instruction did appear to have a positive effect on the quality of the research paper bibliographies in this study; whether the research papers themselves were improved was not investigated. A study which investigated the relationship of the score on the Bibliography Rating Scale and the assigned term paper grade did not find strong correlation (Kohl & Wilson, 1986). The researchers attributed this lack of correlation to numerous factors other than the ability to access information which affect student grades. Researchers may wish to explore the relationship between bibliography ratings and grades on research papers in future research projects.

An incidental benefit of this part of the study was the interest sparked by the bibliography rating method. The expert evaluators were academic librarians, who regularly provide instruction similar to that given the traditional group. After the study was complete, both evaluators expressed an interest in continuing this type of evaluation in the future. Although time-consuming and labor-intensive, this activity provided access to student outcomes of instruction usually unavailable to the librarians. In post-study discussions, the evaluators expressed pleasant surprise at the quality of the student products. This methodology may be used in the future for evaluation of the Valdosta State College library instruction program.

Perceptions of Usefulness of Library Instruction

The results of this study did not support the hypothesis that the cognitive strategies group would report more positive perceptions of the immediate usefulness of library instruction than would the traditional group. The data indicate that the traditional group scored higher, although not significantly, on this measure than did the cognitive strategies group.

Both groups scored well above the midpoint of the range, indicating strongly positive perceptions of the usefulness of library instruction. Ninety-eight percent of the students who received instruction agreed or strongly agreed that the instructional sessions were useful in preparing them to begin their research papers. On another question, only five percent of the students found the sessions to be a waste of time. Responses were similar for questions which dealt with specific steps of the research process. Although the traditional group did not receive specific instruction in the steps of the research process, they apparently did feel that the more resource-oriented instruction they received prepared them to undertake the research process.

A ceiling effect on the scores may be responsible for the failure to find differences between the groups. Ninety percent or more of all subjects responded positively or strongly positively on every usefulness item. Another explanation for the failure to find differences may be that, according to the student perceptions, the treatments were equally beneficial in preparing them to proceed with the research paper assignment. This student perception is supported by informal comments by the course instructors. All three of the English professors who had two classes participating (one in each treatment group) sat in on both treatments and were uniformly pleased with both class sessions.

Research Paper Topic and Title Development

The prediction that the treatment groups would differ in the level of development of the research paper topic and research paper title immediately after instruction was supported by the results of this study. As expected, the cognitive strategies group was more frequently judged to have narrowed or focused topics and titles than the traditional group.

These findings were very likely the result of the problem formulation strategy presented to the cognitive strategies group on the first day of instruction. Students in this group had had group practice in using a framing strategy to select and narrow their research paper topics, and had been given copies of the strategy worksheet (available from the researcher) for their own personal use. Students in the traditional group had been encouraged to narrow and focus their topics, but had not had any specific instruction on how to do so. Library instruction which is closely integrated with assignments has been found to be more effective than general instruction (Oberman, 1984).

There was some threat to the internal validity of this measure due to history bias. Due to timing and due date differences in various professors' assignments, some students may have felt a strong necessity to narrow their topics and generate their term paper titles by the last day of library instruction, while others were on a less immediate time schedule. Future researchers should control for that threat by negotiating uniform assignments and due dates with the professors.

General Discussion

Overall, the results of this study support the use of a domain-integrated process-oriented approach to academic library instruction. The cognitive strategies group showed greater improvement in research process orientation, more reduction in library anxiety, and more positive general attitudes about library instruction than did the traditional group. Moreover, the cognitive strategies group demonstrated more developed research paper topics and titles, and, most importantly, were judged to have compiled more adequate research paper bibliographies than the traditional group. Student perceptions of both methods of instruction were strongly positive.

Certain limitations of the study may undermine the generalizability of these positive findings. The investigation was limited to a single field experiment conducted at one institution. One individual taught all the library instruction sections, thus making it difficult to establish that the results could be applied to other people in other times and places. Other studies that evaluate instruction based on the cognitive strategies treatment method may help in providing evidence for the external validity of this study.

The fact that only one person taught the classes also may bring into question the internal validity of the study. The researcher administered both of the treatments, thus acting as both investigator and teacher. There were practical considerations which led to the decision to administer the treatments in this way. The treatment was long, consisting of three hours of instruction on three consecutive days. Due to job assignments, it was not possible to schedule another librarian for the twenty-four hours of instruction necessary for the eight intact classes. Consideration was given to training several other librarians to share in administering the treatments. This option appeared to be unworkable due to the training time required and the likelihood of introducing teacher effect, a threat to internal validity.

Experts in experimental research strongly discourage the dual role of investigator and teacher due to the inherent danger of experimenter bias (Barber, 1973). This bias can be introduced in several ways including failure to follow protocol. If the experimenter deviates significantly from the specified treatment, the study that is actually conducted may not be the same as the one that is reported. Another way this bias can be introduced is through the expectancy effect. Experimenters (and teachers) commonly expect certain results; they expect that one group will perform differently from the other. This expectancy may result in an unconscious and unintentional influence which may affect the outcome.

To minimize these problems, care was taken to follow the instructional treatments precisely and uniformly. Evidence that this was done can be seen in the similarity of student perceptions of the usefulness of library instruction as measured immediately after instruction. Further evidence can be provided by the English professors who sat in on the instructional sessions. In informal observations, all those who had sections taught by both methods found the sessions to be equal in quality. A formal observation checklist, including such criteria as accuracy, interaction, friendliness, comprehensiveness, etc., would have been useful in documenting these observations.

Taking into account the limitations outlined above, the findings of this study do add to the relatively small body of empirical evidence concerning the effectiveness of process-oriented instruction. Studies of ongoing library instruction programs based on the process approach (Lynch, 1989; Mellon, 1984; Pask & Smith, 1989) are expected to increase this body of evidence. More studies are needed, not only to evaluate the effectiveness of programs on students' library research skills, but to examine the wider and more long-range effects on lifelong information skills.

Practically speaking, the cognitive strategies treatment has been implemented as the method of library instruction used at Valdosta State College. Other librarians have learned the method and have improved upon it; ongoing program evaluation may prove to add useful information in the future.

Conclusion

The basic concern which led to this study was a desire to make library instruction more appropriate to the needs of users today and in the future. Information is today considered to be the basis of the economic, social, and political structure of our society. In this society, people must have self-directing information management skills which are adaptive to changing technologies and environments.

A review of the literature of library and information science, as well as that in learning theory, suggested that the skills needed by a self-reliant information manager were similar to those involved in problem-solving (Dervin, 1977; Gagné, 1985; Reichel, 1987). Field studies by Kuhlthau (1983, 1988a, 1988b) investigated the process of library research, and provided data which support the problem-solving model and led to the development and validation of a new model of the research process (Kuhlthau, Truock, George & Belvin, 1990). This model included not only the actions taken by researchers, but their corresponding thoughts and feelings as well. Kuhlthau's work provided the construct of research process orientation, one of the dependent variables used in this study. The cognitive strategies method of library instruction was shown to increase research process orientation in the context of this study. If this improvement is repeated over a broad range of conditions and instruction, this could be seen as a step toward the goal of developing self-reliant information managers (Lechner, 1989).

A number of researchers have suggested that anxiety is a major problem which must be overcome in order for library users to be able to take full advantage of library instruction and library use (Kuhlthau et al., 1990; Mellon, 1986). Mellon (1986) documented students' attitudes about libraries and the search process, and identified probable sources of fears and anxiety. Her work was important in developing the construct of library anxiety, used as a dependent variable in this study. The cognitive strategies method of library instruction was shown to decrease library anxiety in the context of this study. If this reduction occurs repeatedly in other contexts, this too may support the goal of self-reliance in information searching (Lechner, 1989; Nahl-Jakobovits & Jakobovits, 1985).

The other dependent variables of general attitudes about library instruction, perceptions of usefulness of library instruction, research topic and title development and performance on the research paper bibliography measured the more immediate goals of library instruction. Student achievement of these immediate goals provides evidence of movement toward the achievement of long-term goals such as self-reliance in information searching (Lechner, 1989).

It is hoped that the empirical evidence of the effectiveness of the domain-integrated process-oriented instruction used as a treatment in this study will encourage librarians to design and implement such instruction. Libraries should make it their role to teach not only specific sources and procedures within the local library, but to teach the processes of life-long self-education in a worldwide, electronic environment. In this global view, the library is no longer the context for the learning process; instead, the context is the information society itself.

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1993

AUTHOR INDEX

Author	Descriptors	YR	PG
Allen, B	Computer Mapping	93	1
Allen, B	Curriculum Development	93	1
Anderson, J	Technology & Classrooms	93	25
Anderson, J	Re-Design of Classrooms	93	25
Anderson, J	Disciplinary Technology	93	54
Anderson, J	Foucault	93	54
Arnone, M	Curiosity & Learning	93	79
Arnone, M	Learning in an Interactive Environment	93	79
Aust, R	Wide-Area Networks	93	115
Aust, R	Network Resources for Teacher Ed.	93	115
Baker, L	Educational Partnerships	93	125
Baker, L	Success of Partnerships & Technology	93	125
Beissner, K	Graphic Techniques & Knowledge	93	155
Beissner, K	Selecting Graphic Techniques	93	155
Bohlin, R	Motivation of Adults	93	177
Bohlin, R	Analysis of Instruction & Adults	93	177
Bohlin, R	Computer Attitudes	93	193
Bohlin, R	Course Structure & Attitudes	93	193
Broholm, J	Teachers and E-Mail	93	199
Broholm, J	Networking and Teachers	93	199
Cahsman, C	Research in Instructional Technology	93	207
Carr, A	Modeling & Problem Solving	93	373
Carr, A	Computer-Based Learning	93	373
Cashman, C	Research Methods & Techniques	93	207
Cates, W	Multimedia & Thinking Skills	93	351
Cates, W	Higher-Order Thinking Skills	93	351
Cennamo, K	Preconceptions & Effort	93	215
Cennamo, K	Learning from Video	93	215
Cennamo, K	Preconceptions & Learning Outcomes	93	231
Cennamo, K	Mediated Instruction	93	231
Chen, L	Motion Visuals & Learning	93	243
Chen, L	Visual Complexity & Children	93	243
Cichocki, R	Technology & Classrooms	93	25
Cichocki, R	Re-Design of Classrooms	93	25
Cole, P	Analogies & Problem Solving	93	255
Cole, P	Spontaneous Generation of Analogies	93	255
Cole, P	Learner Questions & Comments	93	265
Cole, P	Improving Instruction	93	265
Cole, P	Semantic Relationships	93	425
Cole, P	Learner vs Instructor Analysis	93	425
Cronin, M	Interactive Video Instruction	93	283
Cronin, M	Video & Oral Communication	93	283
Cyr, T	Peakview Elementary School	93	1151
Cyr, T	Evaluating the Impact of Technology	93	1151
Davidson, G	Group Computer Instruction & Achievement	93	781

Author	Descriptors	YR	PG
Davidson, G	Group Instruction & Learning Style	93	781
Davis, M	Technology & Restructuring Schools	93	309
Davis, M	Two Restructuring Schools	93	309
Dede, C	Multimedia & Thinking Skills	93	351
Dede, C	Higher-Order Thinking Skills	93	351
Dempsey, J	Error & Feedback	93	325
Dempsey, J	Content Analysis & Confidence	93	325
Dodge, B	Learner/Computer Interaction	93	1115
Dodge, B	Tracking & Analyzing Interaction	93	1115
Doran, M	Performance & Attitudes	93	335
Doran, M	Peer Collaboration in Accounting	93	335
Driscoll, M	Error & Feedback	93	325
Driscoll, M	Content Analysis & Confidence	93	325
Driscoll, M	Qualitative Research Methods	93	833
Driscoll, M	Research Methods Workshop	93	833
Duffy, T	Modeling & Problem Solving	93	373
Duffy, T	Computer-Based Learning	93	373
Duffy, T	Connect Home & School	93	697
Duffy, T	Extending the Learning Environment	93	697
Erchul, J	Cooperative Learning & Motivation	93	533
Erchul, J	Cooperative Learning & Incentive	93	533
Erchul, J	Reward & Performance	93	543
Erchul, J	Cooperative Learning & Reward	93	543
Farr, C	ID	93	731
Farr, C	The Value of Immediacy	93	731
Fontana, L	Multimedia & Thinking Skills	93	351
Fontana, L	Higher-Order Thinking Skills	93	351
Foss, J	Interaction & Achievement	93	517
Foss, J	Interactive Dissection & Performance	93	517
Fowler, K	Collaborative Problem Solving	93	895
Fowler, K	Computer-Mediated Communications	93	895
Gibson, J	Collaborative Problem Solving	93	895
Gibson, J	Computer-Mediated Communications	93	895
Grabowski, B	Graphic Techniques & Knowledge	93	155
Grabowski, B	Selecting Graphic Techniques	93	155
Grabowski, B	Curiosity & Learning	93	79
Grabowski, B	Learning in an Interactive Environment	93	79
Gueulette, D	Culturefax	93	365
Gueulette, D	International Training	93	365
Hamilton, R	Peakview Elementary School	93	1151
Hamilton, R	Evaluating the Impact of Technology	93	1151
Harris, B	Learning Strategies	93	641
Harris, B	Teaching Self-Regulated Strategies	93	641
Henry, M	Technology & Restructuring Schools	93	309
Henry, M	Two Restructuring Schools	93	309

Author	Descriptors	YR	PG
Hlynka, D	Paradigms Reframed	93	57
Hlynka, D	Educational Technology	93	57
Hoffman, R	Computer Mapping	93	1
Hoffman, R	Curriculum Development	93	1
Honebein, P	Modeling & Problem Solving	93	373
Honebein, P	Computer-Based Learning	93	373
Hooper, S	Learning & Achievement	93	1021
Hooper, S	Learner Control & High vs Low Achievers	93	1021
Hunt, N	Computer Attitudes	93	193
Hunt, N	Course Structure & Attitudes	93	193
Jakobsdóttir, S	Computer Graphics for different sexes	93	407
Jakobsdóttir, S	Designing Gender-Based Graphics	93	407
Januszewski, A	Foundations & Technology	93	59
Januszewski, A	New Area for AECT	93	59
Jo, M	Problem Solving Strategies	93	415
Jo, M	Hints & Learner Control	93	415
Johnston, M	Digitized Speech	93	851
Johnston, M	Feedback in Computer-Based Instruction	93	851
Jonassen, D	Graphic Techniques & Knowledge	93	155
Jonassen, D	Selecting Graphic Techniques	93	155
Jonassen, D	Semantic Relationships	93	425
Jonassen, D	Learner vs Instructor Analysis	93	425
Jones, J	Distance Education	93	441
Jones, J	A Cost Analysis	93	441
Kenny, R	Instructional Activities	93	495
Kenny, R	Computer-Based Instruction	93	495
Kinzie, M	Interaction & Achievement	93	517
Kinzie, M	Interactive Dissection & Performance	93	517
Klein, J	Performance & Attitudes	93	335
Klein, J	Peer Collaboration in Accounting	93	335
Klein, J	Cooperative Learning & Motivation	93	533
Klein, J	Cooperative Learning & Incentive	93	533
Klein, J	Reward & Performance	93	543
Klein, J	Cooperative Learning & Reward	93	543
Klein, J	Feedback & Computers	93	803
Klein, J	Learner Control & Computers	93	803
Knupfer, N	Channel One	93	565
Knupfer, N	Student, Teacher & Parent Reactions	93	565
Knupfer, N	Groupware	93	585
Knupfer, N	Interpersonal Computing	93	585
Koetting, R	Unquiet Pedagogy	93	63
Koetting, R	Modern Cultural Climate	93	63
Kolloff, M	Library Media	93	593
Kolloff, M	Restructuring in Kentucky	93	593
Kompella, J	Computer Mapping	93	1

Author	Descriptors	YR	PG
Kompella, J	Curriculum Development	93	1
Krey, C	Computer Graphics for different sexes	93	407
Krey, C	Designing Gender-Based Graphics	93	407
Kushigian, R	Instructional Development	93	627
Kushigian, R	Configurational Inquiry	93	627
La Follette, J	Interactivity & Multimedia	93	597
La Follette, J	Design & Multimedia Instruction	93	597
Li, M	Thought, Instruction & Design	93	613
Li, M	Empowering Learners	93	613
Liang, C	Instructional Development	93	627
Liang, C	Configurational Inquiry	93	627
Lindner, R	Learning Strategies	93	641
Lindner, R	Teaching Self-Regulated Strategies	93	641
Lowther, D	Ethnicity & Reading	93	655
Lowther, D	Reading Preferences of Children	93	655
Lu, M	Survey of Media in Industry	93	719
Lu, M	Survey of Media in N. California	93	719
Lucas, L	Computer-Assisted Instruction	93	669
Lucas, L	Interface Types & Learning	93	669
Marcinkiewicz, H	Assessing Teachers' Computer Use	93	679
Marcinkiewicz, H	Instructional Transformation	93	679
McCraw, P	Research in Instructional Technology	93	207
McCraw, P	Research Methods & Techniques	93	207
McIsaac, M	Global Classroom	93	685
McIsaac, M	An International Perspective	93	685
McLellan, H	Groupware	93	585
McLellan, H	Interpersonal Computing	93	585
McMahon, T	Connect Home & School	93	697
McMahon, T	Extending the Learning Environment	93	697
Milheim, W	Motivation of Adults	93	177
Milheim, W	Analysis of Instruction & Adults	93	177
Morlan, J	Survey of Media in Industry	93	719
Morlan, J	Survey of Media in N. California	93	719
Muffoletto, R	Equity & Social Justice	93	67
Muffoletto, R	Schools & Democratic Society	93	67
Murphy, K	ID	93	731
Murphy, K	The Value of Immediacy	93	731
Newhouse, B	Teacher Needs Hierarchy	93	1001
Newhouse, B	Performance and Distance Learning	93	1001
Nichols, R	Teachers & Technology	93	73
Nichols, R	Theory, Technology & Ethics	93	73
Nichols, R	Instructional Materials Evaluation	93	743
Nichols, R	Evaluation & Instructional Preparation	93	743
Nuttall, A	Learning Strategies/ Training	93	753
Nuttall, A	Design of Effective Strategies	93	753

Author	Descriptors	YR	PG
Orr, K	Group Computer Instruction & Achievement	93	781
Orr, K	Group Instruction & Learning Style	93	781
Persichitte, K	Metacognitive Development	93	793
Persichitte, K	An Inservice Design	93	793
Piña, A	Practice & Recall	93	797
Piña, A	Effects of Two Practice Strategies	93	797
Pridemore, D	Cooperative Learning & Motivation	93	533
Pridemore, D	Cooperative Learning & Incentive	93	533
Pridemore, D	Reward & Performance	93	543
Pridemore, D	Cooperative Learning & Reward	93	543
Pridemore, D	Feedback & Computers	93	803
Pridemore, D	Learner Control & Computers	93	803
Quade, A	Hypertext	93	809
Quade, A	Assessment of Instructional Systems	93	809
Reehm, S	Library Media	93	593
Reehm, S	Restructuring in Kentucky	93	593
Reeves, T	Learner Control Research	93	819
Reeves, T	Pseudoscience in Instructional Tech.	93	819
Richmond, A	Practice & Recall	93	797
Richmond, A	Effects of Two Practice Strategies	93	797
Robinson, R	Instructional Materials Evaluation	93	743
Robinson, R	Evaluation & Instructional Preparation	93	743
Robinson, R	Qualitative Research Methods	93	833
Robinson, R	Research Methods Workshop	93	833
Rodriguez, S	Motivation & Grad Students	93	845
Rodriguez, S	A Descriptive Study	93	845
Sales, G	Digitized Speech	93	851
Sales, G	Feedback in Computer-Based Instruction	93	851
Savenye, W	Teacher Attitudes & Computers	93	867
Savenye, W	Measuring Computer Attitudes	93	867
Schwier, R	Classifying Interaction	93	881
Schwier, R	Implications for Learner Control	93	881
Scott, D	Collaborative Problem Solving	93	895
Scott, D	Computer-Mediated Communications	93	895
Shank, G	Qualitative vs. Quantitative Research	93	903
Shank, G	A Postconstructivist Approach	93	903
Sherman, G	Narration & Instruction	93	931
Sherman, G	Varying Format in an Instructional Film	93	931
Shiu, K	Practicing Chinese	93	949
Shiu, K	Computer vs. Audio Comparison Study	93	949
Simonson, M	Distance Education	93	441
Simonson, M	A Cost Analysis	93	441
Simsek, A	Computer-Based Cooperative Learning	93	953
Simsek, A	Learner Control & Group Composition	93	953
Slee, E	Foundations & Technology	93	59

Author	Descriptors	YR	PG
Slee, E	New Area for AECT	93	59
Smaldino, S	Practicing Chinese	93	949
Smaldino, S	Computer vs. Audio Comparison Study	93	949
Sticht, T	Computer Mapping	93	1
Sticht, T	Curriculum Development	93	1
Strauss, R	Interaction & Achievement	93	517
Strauss, R	Interactive Dissection & Performance	93	517
Strommen, E	Computer Difficulty for Children	93	991
Strommen, E	Preschool Children at the Interface	93	991
Sullivan, H	Performance & Attitudes	93	335
Sullivan, H	Peer Collaboration in Accounting	93	335
Sullivan, H	Ethnicity & Reading	93	655
Sullivan, H	Reading Preferences of Children	93	655
Talab, R	Teacher Needs Hierarchy	93	1001
Talab, R	Performance and Distance Learning	93	1001
Temiyakarn, C	Learning & Achievement	93	1021
Temiyakarn, C	Learner Control & High vs Low Achievers	93	1021
Teslow, J	Peakview Elementary School	93	1151
Teslow, J	Evaluating the Impact of Technology	93	1151
Todd, N	Faculty Concerns & Competency	93	1039
Todd, N	Teachers & Computer Technologies	93	1039
Tucker, S	A Cognitive Model	93	1047
Tucker, S	Interactive Instructional Technologies	93	1047
Tucker, S	Instructional Technologies	93	1047
Tucker, S	Evaluating Interactive Instruction	93	1047
Tuscher, L	Computer-Assisted Instruction	93	669
Tuscher, L	Interface Types & Learning	93	669
Viechnicki, K	Motivation of Adults	93	177
Viechnicki, K	Analysis of Instruction & Adults	93	177
Welliver, P	Assessing Teachers' Computer Use	93	679
Welliver, P	Instructional Transformation	93	679
White, C	Multimedia & Thinking Skills	93	351
White, C	Higher-Order Thinking Skills	93	351
Wiegmann, B	Instructional Materials Evaluation	93	743
Wiegmann, B	Evaluation & Instructional Preparation	93	743
Williams, M	Learner Characteristics	93	1083
Williams, M	A Review of Learner-Control	93	1083
Williams, M	Learner/Computer Interaction	93	1115
Williams, M	Tracking & Analyzing Interaction	93	1115
Wilson, B	Analogies & Problem Solving	93	255
Wilson, B	Spntaneous Generation of Analogies	93	255
Wilson, B	Instructional Design	93	1131
Wilson, B	Constructivism - Personal Reflections	93	1131
Wilson, B	Peakview Elementary School	93	1151
Wilson, B	Evaluating the Impact of Technology	93	1151

Author	Descriptors	YR PG
Yeaman, A	Jacques Derrida	93 77
Yeaman, A	French Influence on Modern Teaching	93 77
Zahner, J	Library Instruction	93 1169
Zahner, J	Integrating Domains of Instruction	93 1169

1993

DESCRIPTOR INDEX

Descriptors	Author	YR	PG
A Cognitive Model	Tucker, S	93	1047
A Cost Analysis	Jones, J	93	441
A Cost Analysis	Simonson, M	93	441
A Descriptive Study	Rodriguez, S	93	845
A Postconstructivist Approach	Shank, G	93	903
A Review of Learner-Control	Williams, M	93	1083
An Inservice Design	Persichitte, K	93	793
An International Perspective	McIsaac, M	93	685
Analogies & Problem Solving	Cole, P	93	255
Analogies & Problem Solving	Wilson, B	93	255
Analysis of Instruction & Adults	Bohlin, R	93	177
Analysis of Instruction & Adults	Milheim, W	93	177
Analysis of Instruction & Adults	Viechnicki, K	93	177
Assessing Teachers' Computer Use	Marcinkiewicz, H	93	679
Assessing Teachers' Computer Use	Welliver, P	93	679
Assessment of Instructional Systems	Quade, A	93	809
Channel One	Knupfer, N	93	565
Classifying Interaction	Schwier, R	93	881
Collaborative Problem Solving	Fowler, K	93	895
Collaborative Problem Solving	Gibson, J	93	895
Collaborative Problem Solving	Scott, D	93	895
Computer Mapping	Kompella, J	93	1
Computer Attitudes	Bohlin, R	93	193
Computer Attitudes	Hunt, N	93	193
Computer Difficulty for Children	Strommen, E	93	991
Computer Graphics for different sexes	Jakobsdóttir, S	93	407
Computer Graphics for different sexes	Krey, C	93	407
Computer Mapping	Allen, B	93	1
Computer Mapping	Hoffman, R	93	1
Computer Mapping	Sticht, T	93	1
Computer vs. Audio Comparison Study	Shiu, K	93	949
Computer vs. Audio Comparison Study	Smaldino, S	93	949
Computer-Assisted Instruction	Lucas, L	93	669
Computer-Assisted Instruction	Tuscher, L	93	669
Computer-Based Cooperative Learning	Simsek, A	93	953
Computer-Based Instruction	Kenny, R	93	495
Computer-Based Learning	Carr, A	93	373
Computer-Based Learning	Duffy, T	93	373
Computer-Based Learning	Honebein, P	93	373
Computer-Mediated Communications	Fowler, K	93	895
Computer-Mediated Communications	Gibson, J	93	895
Computer-Mediated Communications	Scott, D	93	895
Configurational Inquiry	Kushigian, R	93	627
Configurational Inquiry	Liang, C	93	627
Connect Home & School	Duffy, T	93	697

Descriptors	Author	YR	PG
Connect Home & School	McMahon, T	93	697
Constructivism - Personal Reflections	Wilson, B	93	1131
Content Analysis & Confidence	Dempsey, J	93	325
Content Analysis & Confidence	Driscoll, M	93	325
Cooperative Learning & Incentive	Erchul, J	93	533
Cooperative Learning & Incentive	Klein, J	93	533
Cooperative Learning & Incentive	Pridemore, D	93	533
Cooperative Learning & Motivation	Erchul, J	93	533
Cooperative Learning & Motivation	Klein, J	93	533
Cooperative Learning & Motivation	Pridemore, D	93	533
Cooperative Learning & Reward	Erchul, J	93	543
Cooperative Learning & Reward	Klein, J	93	543
Cooperative Learning & Reward	Pridemore, D	93	543
Course Structure & Attitudes	Bohlin, R	93	193
Course Structure & Attitudes	Hunt, N	93	193
Culturefax	Gueulette, D	93	365
Curiosity & Learning	Arnone, M	93	79
Curiosity & Learning	Grabowski, B	93	79
Curriculum Development	Allen, B	93	1
Curriculum Development	Hoffman, R	93	1
Curriculum Development	Kompella, J	93	1
Curriculum Development	Sticht, T	93	1
Design & Multimedia Instruction	La Follette, J	93	597
Design of Effective Strategies	Nuttall, A	93	753
Designing Gender-Based Graphics	Jakobsdóttir, S	93	407
Designing Gender-Based Graphics	Krey, C	93	407
Digitized Speech	Johnston, M	93	851
Digitized Speech	Sales, G	93	851
Disciplinary Technology	Anderson, J	93	54
Distance Education	Jones, J	93	441
Distance Education	Simonson, M	93	441
Educational Partnerships	Baker, L	93	125
Educational Technology	Hlynka, D	93	57
Effects of Two Practice Strategies	Piña, A	93	797
Effects of Two Practice Strategies	Richmond, A	93	797
Empowering Learners	Li, M	93	613
Equity & Social Justice	Muffoletto, R	93	67
Error & Feedback	Dempsey, J	93	325
Error & Feedback	Driscoll, M	93	325
Ethnicity & Reading	Lowther, D	93	655
Ethnicity & Reading	Sullivan, H	93	655
Evaluating Interactive Instruction	Tucker, S	93	1047
Evaluating the Impact of Technology	Cyr, T	93	1151
Evaluating the Impact of Technology	Hamilton, R	93	1151
Evaluating the Impact of Technology	Teslow, J	93	1151

Descriptors	Author	YR	PG
Evaluating the Impact of Technology	Wilson, B	93	1151
Evaluation & Instructional Preparation	Nichols, R	93	743
Evaluation & Instructional Preparation	Robinson, R	93	743
Evaluation & Instructional Preparation	Wiegmann, B	93	743
Extending the Learning Environment	Duffy, T	93	697
Extending the Learning Environment	McMahon, T	93	697
Faculty Concerns & Competency	Todd, N	93	1039
Feedback & Computers	Klein, J	93	803
Feedback & Computers	Pridemore, D	93	803
Feedback in Computer-Based Instruction	Johnston, M	93	851
Feedback in Computer-Based Instruction	Sales, G	93	851
Foucault	Anderson, J	93	54
Foundations & Technology	Januszewski, A	93	59
Foundations & Technology	Slee, E	93	59
French Influence on Modern Teaching	Yeaman, A	93	77
Global Classroom	McIsaac, M	93	685
Graphic Techniques & Knowledge	Beissner, K	93	155
Graphic Techniques & Knowledge	Grabowski, B	93	155
Graphic Techniques & Knowledge	Jonassen, D	93	155
Group Computer Instruction & Achievement	Davidson, G	93	781
Group Computer Instruction & Achievement	Orr, K	93	781
Group Instruction & Learning Style	Davidson, G	93	781
Group Instruction & Learning Style	Orr, K	93	781
Groupware	Knupfer, N	93	585
Groupware	McLellan, H	93	585
Higher-Order Thinking Skills	Cates, W	93	351
Higher-Order Thinking Skills	Dede, C	93	351
Higher-Order Thinking Skills	Fontana, L	93	351
Higher-Order Thinking Skills	White, C	93	351
Hints & Learner Control	Jo, M	93	415
Hypertext	Quade, A	93	809
ID	Farr, C	93	731
ID	Murphy, K	93	731
Implications for Learner Control	Schwier, R	93	881
Improving Instruction	Cole, P	93	265
Instructional Activities	Kenny, R	93	495
Instructional Design	Wilson, B	93	1131
Instructional Development	Kushigian, R	93	627
Instructional Development	Liang, C	93	627
Instructional Materials Evaluation	Nichols, R	93	743
Instructional Materials Evaluation	Robinson, R	93	743
Instructional Materials Evaluation	Wiegmann, B	93	743
Instructional Technologies	Tucker, S	93	1047
Instructional Transformation	Marcinkiewicz, H	93	679
Instructional Transformation	Welliver, P	93	679

Descriptors	Author	YR PG
Integrating Domains of Instruction	Zahner, J	93 1169
Interaction & Achievement	Foss, J	93 517
Interaction & Achievement	Kinzie, M	93 517
Interaction & Achievement	Strauss, R	93 517
Interactive Dissection & Performance	Foss, J	93 517
Interactive Dissection & Performance	Kinzie, M	93 517
Interactive Dissection & Performance	Strauss, R	93 517
Interactive Instructional Technologies	Tucker, S	93 1047
Interactive Video Instruction	Cronin, M	93 283
Interactivity & Multimedia	La Follette, J	93 597
Interface Types & Learning	Lucas, L	93 669
Interface Types & Learning	Tuscher, L	93 669
International Training	Gueulette, D	93 365
Interpersonal Computing	Knupfer, N	93 585
Interpersonal Computing	McLellan, H	93 585
Jacques Derrida	Yeaman, A	93 77
Learner Characteristics	Williams, M	93 1083
Learner Control & Computers	Klein, J	93 803
Learner Control & Computers	Pridemore, D	93 803
Learner Control & Group Composition	Simsek, A	93 953
Learner Control & High vs Low Achievers	Hooper, S	93 1021
Learner Control & High vs Low Achievers	Temiyakarn, C	93 1021
Learner Control Research	Reeves, T	93 819
Learner Questions & Comments	Cole, P	93 265
Learner vs Instructor Analysis	Cole, P	93 425
Learner vs Instructor Analysis	Jonassen, D	93 425
Learner/Computer Interaction	Dodge, B	93 1115
Learner/Computer Interaction	Williams, M	93 1115
Learning & Achievement	Hooper, S	93 1021
Learning & Achievement	Temiyakarn, C	93 1021
Learning from Video	Cennamo, K	93 215
Learning in an Interactive Environment	Arnone, M	93 79
Learning in an Interactive Environment	Grabowski, B	93 79
Learning Strategies	Harris, B	93 641
Learning Strategies	Lindner, R	93 641
Learning Strategies/ Training	Nuttall, A	93 753
Library Instruction	Zahner, J	93 1169
Library Media	Kolloff, M	93 563
Library Media	Reehm, S	93 593
Measuring Computer Attitudes	Savenye, W	93 867
Mediated Instruction	Cennamo, K	93 231
Metacognitive Development	Persichitte, K	93 793
Modeling & Problem Solving	Carr, A	93 373
Modeling & Problem Solving	Duffy, T	93 373
Modeling & Problem Solving	Honebein, P	93 373

Descriptors	Author	YR	PG
Modern Cultural Climate	Koetting, R	93	63
Motion Visuals & Learning	Chen, L	93	243
Motivation & Grad Students	Rodriguez, S	93	845
Motivation of Adults	Bohlin, R	93	177
Motivation of Adults	Milheim, W	93	177
Motivation of Adults	Viechnicki, K	93	177
Multimedia & Thinking Skills	Cates, W	93	351
Multimedia & Thinking Skills	Dede, C	93	351
Multimedia & Thinking Skills	Fontana, L	93	351
Multimedia & Thinking Skills	White, C	93	351
Narration & Instruction	Sherman, G	93	931
Network Resources for Teacher Ed.	Aust, R	93	115
Networking and Teachers	Broholm, J	93	199
New Area for AECT	Januszewski, A	93	59
New Area for AECT	Slee, E	93	59
Paradigms Reframed	Hlynka, D	93	57
Peakview Elementary School	Hamilton, R	93	1151
Peakview Elementary School	Teslow, J	93	1151
Peakview Elementary School	Wilson, B	93	1151
Peakview Elementary School	Cyr, T	93	1151
Peer Collaboration in Accounting	Doran, M	93	335
Peer Collaboration in Accounting	Klein, J	93	335
Peer Collaboration in Accounting	Sullivan, H	93	335
Performance & Attitudes	Doran, M	93	335
Performance & Attitudes	Klein, J	93	335
Performance & Attitudes	Sullivan, H	93	335
Performance and Distance Learning	Newhouse, B	93	1001
Performance and Distance Learning	Talab, R	93	1001
Practice & Recall	Piña, A	93	797
Practice & Recall	Richmond, A	93	797
Practicing Chinese	Shiu, K	93	949
Practicing Chinese	Smaldino, S	93	949
Preconceptions & Effort	Cennamo, K	93	215
Preconceptions & Learning Outcomes	Cennamo, K	93	231
Preschool Children at the Interface	Strommen, E	93	991
Problem Solving Strategies	Jo, M	93	415
Pseudoscience in Instructional Tech.	Reeves, T	93	819
Qualitative Research Methods	Driscoll, M	93	833
Qualitative Research Methods	Robinson, R	93	833
Qualitative vs. Quantitative Research	Shank, G	93	903
Re-Design of Classrooms	Anderson, J	93	25
Re-Design of Classrooms	Cichocki, R	93	25
Reading Preferences of Children	Lowther, D	93	655
Reading Preferences of Children	Sullivan, H	93	655
Research in Instructional Technology	Cahsman, C	93	207

Descriptors	Author	YR	PG
Research in Instructional Technology	McCraw, P	93	207
Research Methods & Techniques	Cashman, C	93	207
Research Methods & Techniques	McCraw, P	93	207
Research Methods Workshop	Driscoll, M	93	833
Research Methods Workshop	Robinson, R	93	833
Restructuring in Kentucky	Kolloff, M	93	593
Restructuring in Kentucky	Reehm, S	93	593
Reward & Performance	Erchul, J	93	543
Reward & Performance	Klein, J	93	543
Reward & Performance	Pridemore, D	93	543
Schools & Democratic Society	Muffoletto, R	93	67
Selecting Graphic Techniques	Beissner, K	93	155
Selecting Graphic Techniques	Grabowski, B	93	155
Selecting Graphic Techniques	Jonassen, D	93	155
Semantic Relationships	Cole, P	93	425
Semantic Relationships	Jonassen, D	93	425
Spntaneous Generation of Analogies	Wilson, B	93	255
Spontaneous Generation of Analogies	Cole, P	93	255
Student, Teacher & Parent Reactions	Knupfer, N	93	565
Success of Partnerships & Technology	Baker, L	93	125
Survey of Media in Industry	Lu, M	93	719
Survey of Media in Industry	Morlan, J	93	719
Survey of Media in N. California	Lu, M	93	719
Survey of Media in N. California	Morlan, J	93	719
Teacher Attitudes & Computers	Savenye, W	93	867
Teacher Needs Hierarchy	Newhouse, B	93	1001
Teacher Needs Hierarchy	Talab, R	93	1001
Teachers & Computer Technologies	Todd, N	93	1039
Teachers & Technology	Nichols, R	93	73
Teachers and E-Mail	Broholm, J	93	199
Teaching Self-Regulated Strategies	Harris, B	93	641
Teaching Self-Regulated Strategies	Lindner, R	93	641
Technology & Classrooms	Anderson, J	93	25
Technology & Classrooms	Cichocki, R	93	25
Technology & Restructuring Schools	Davis, M	93	309
Technology & Restructuring Schools	Henry, M	93	309
The Value of Immediacy	Farr, C	93	731
The Value of Immediacy	Murphy, K	93	731
Theory, Technology & Ethics	Nichols, R	93	73
Thought, Instruction & Design	Li, M	93	613
Tracking & Analyzing Interaction	Dodge, B	93	1115
Tracking & Analyzing Interaction	Williams, M	93	1115
Two Restructuring Schools	Davis, M	93	309
Two Restructuring Schools	Henry, M	93	309
Unquiet Pedagogy	Koetting, R	93	63

Descriptors	Author	YR PG
Varying Format in an Instructional Film	Sherman, G	93 931
Video & Oral Communication	Cronin, M	93 283
Visual Complexity & Children	Chen, L	93 243
Wide-Area Networks	Aust, R	93 115